Maine Sustainability & Water Conference

March 28, 2019

Augusta Civic Center • Augusta, Maine

THE UNIVERSITY OF MAINE

Senator George J. Mitchell Center for Sustainability Solutions

University of Maine, Orono, Maine

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Credits and Contact Hours (Please check individual sessions for details)

Drinking Water Operators: Training Contact Hours (TCH) are available for select talks in sessions 5, 8, 11 and 14 from the Maine CDC Drinking Water Program. Sign-up sheets are located in the individual session rooms.

Wastewater Operators: Sessions 4 and 11 are approved for training contact hours (TCH) through Maine's Wastewater Operator Certification Program. Sign-up sheets are located in the individual session rooms.

Planners: Credits are available for sessions 1, 2, 3, 8, 9, 10, 11, 12, 14 and the keynote session from the American Planning Association American Institute of Certified Planners. Credits must be applied for on the APA AICP website.

Foresters: The Society of American Foresters has approved 1.5 Category 1 CFE credits for Session 12. A sign-up sheet is located in the session room.

Engineers: Certificates of attendance are available. Sign-in at the registration table if you need a certificate for PDH verification.

General: 0.5 Continuing Education Units (CEU) are approved for conference attendance through the University of Maine. Sign-up sheets to receive CEUs are located in the registration area.

Conference Agenda

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

8:30 AM Morning Concurrent Sessions

Session 1: Recovery of the Penobscot River (Washington/York Room - 2nd floor)

Session 2: Sustainable Practices Across Diverse Food Systems (Sagadahoc Room - 2nd floor)

Session 3: Climate Change Policy (Fort Western Room - North Wing, 1st floor)

Session 4: Clean Water Careers (Piscataquis Room - 2nd floor)

Session 5: The Importance of Long-Term Data (Howard Room - North Wing, 1st floor)

Session 6: Alewife Restoration and Lake Water Quality (Augusta Room - North Wing, 2nd floor)

Session 7: Developing Effective Sustainability Curricula (Arnold Room - North Wing, 1st floor)

Session 8: Decision Support for Sustainability (Pine Tree Room - North Wing, 2nd floor)

Session 9: Migratory Fish Passage (Cumberland Room - 1st floor)

10:30 AM Morning Break and Poster Session — Auditorium

11:30 AM Keynote Address — Auditorium

12:30 PM Lunch & Poster Award Presentations — Auditorium

1:30 PM Afternoon Concurrent Sessions

Session 6: Alewife Restoration and Lake Water Quality (Augusta Room - North Wing, 2nd floor)

Session 7: Developing Effective Sustainability Curricula (Arnold Room - North Wing, 1st floor)

Session 8: Decision Support for Sustainability (Pine Tree Room - North Wing, 2nd floor)

Session 9: Migratory Fish Passage (Cumberland Room - 1st floor)

Session 10: The Saco Watershed Collaborative (Howard Room - North Wing, 1st floor)

Session 11: Infrastructure for Wastewater Treatment Facilities (Sagadahoc Room - 2nd floor)

Session 12: UMaine's Forest Climate Change Initiative (Fort Western Room - North Wing, 1st floor)

Session 13: The Literature of Water: Poetry & Prose (Piscataquis Room - 2nd floor)

Session 14: Interagency Forum on Climate Activities (Washington/York Room - 2nd floor)

2:30 PM Afternoon Break — Auditorium

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

4:00 PM Conference Close

Keynote Address and Poster Award Presentations

11:30AM Welcome

David Hart

Director, Senator George J. Mitchell Center for Sustainability Solutions, University of Maine, Orono, ME; david.hart@maine.edu

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

11:32AM Poetry Reading

Gary Lawless

Co-owner of Gulf of Maine bookstore; publisher of 21 poetry collections; awarded the 2017 Constance H. Carlson Public Humanities Prize

11:37AM Keynote Speaker Introduction

David Hart

Director, Senator George J. Mitchell Center for Sustainability Solutions, University of Maine, Orono, ME; david.hart@maine.edu

11:40AM Keynote Speaker

Bridie McGreavy

Assistant Professor, Environmental Communication, Dept. of Communication and Journalism; Faculty Fellow, Senator George J. Mitchell Center for Sustainability Solutions, University of Maine; bridie.mcgreavy@maine.edu

Thinking with Rivers: Communication for Conservation and Sustainability

Finding effective, creative, and inclusive ways to communicate for conservation and sustainability are much needed in today's world. In this talk, Bridie McGreavy shares how thinking with rivers provides one means for such communication. McGreavy draws from her research and experiences in and beyond Maine, as well as insights from communication studies, environmental communication, and sustainability science, to describe specific approaches for communicating conservation, sustainability, and justice efforts. From the Saco to the Penobscot to the St. Croix, thinking with rivers helps identify how to connect across differences in perspective, find common ground, and enrich our imaginations for what communication is and how it matters for this place we call home.

***Bridie McGreavy** studies how communication shapes sustainability and justice efforts in coastal shellfishing communities, river restoration and freshwater conservation initiatives, and a range of collaborations to address complex problems. McGreavy currently serves as President of the National Communication Associa-*

Keynote Address and Poster Presentations

tion's Environmental Communication Division, an interest group of the largest professional organization focused on communication in the United States. In Maine, she helps lead numerous efforts to strengthen shellfish co-management, including through her role as Vice Chair of the Maine Shellfish Advisory Council which focuses on connecting shellfish industry interests with state management and policy-making. More recently, she has been working with representatives from the Department of Natural Resources in the Penobscot Nation to help students learn about the important relationships between the tribe and the Penobscot River. McGreavy has Maine roots and grew up in the Saco River watershed, a river that taught her how to swim and so much more.

** 1 credit is available for the keynote session through APA AICP*

12:30PM Lunch

1:15PM Poster Award Presentations

Presentation of poster awards by **David Hart**, Director, Senator George J. Mitchell Center for Sustainability Solutions, University of Maine and **Robert Lent**, Associate Director for Hydrologic Surveillance Programs, U.S. Geological Survey Northeast Region.

Session 1 (Morning Session)

Recovery of the Penobscot River: 150 Years of Change

The Penobscot River watershed, the largest and most significant watershed in the state, has been the home of the Penobscot Nation for millennia, the inspiration for Thoreau's writings on wilderness, the industrial engine of the 20th century, and most recently, site of one of the most far reaching and innovative river restoration projects in the U.S. The session will review the history of the river, effects that policy changes such as the Clean Water Act and Maine River Study have had, how the region's social and economic context have changed, and how the recent reconfiguration of the hydropower system of the river have all converged to cause a dramatic recovery. The ecosystem has been revived, water quality is the best it has been for a century, fish are returning by the millions.

** 2 credits are available for this session through APA AICP*

Photo courtesy Josh Royte, TNC

Session Overview

8:30AM – 8:55AM Alice R. Kelley
The Penobscot River: From Glaciers to a Modern River

9:00AM – 9:25AM Daniel Kusnierz
The Healing of a River: Changes in Penobscot River Water Quality Over the Past 25 Years

9:30AM – 9:55AM Catlin Ames
Recovery of an Historic Resource: Shortnose and Atlantic Sturgeon Abundance in the Penobscot River

10:00AM – 10:25AM Samuel G. Roy
A Data-Driven Approach to Planning River Barrier Decisions in the Penobscot River, Maine

Session Co-Chairs

Dave Courtemanch
The Nature Conservancy, Brunswick, ME; david.courtemanch@tnc.org

Molly Payne Wynne
The Nature Conservancy, Brunswick, ME; molly.paynewynne@tnc.org

Session 1 - Recovery of the Penobscot River

Dave Courtemanch spent much of his career with the Maine Dept. of Environmental Protection (DEP), progressively from aquatic biologist to Director of Environmental Assessment. In that role he had responsibility for monitoring and assessment of the state's waters. He had responsibility for development of many of the state's water quality standards including the revision of the state's water classification system. A primary focus of his work has been the establishment of biologically-based water quality standards and assessment techniques. He has been involved in a number of river restoration and protection projects around the state, most recently working on restoration of the Penobscot River, both during his former position at the Maine DEP and presently with The Nature Conservancy (TNC) as Freshwater Science and Policy Specialist. At TNC he is engaged in a variety of water-related conservation projects in Maine, U.S., and internationally.

Molly Payne Wynne oversees studies that expand our understanding of migratory fish in Maine and scientifically document the impacts that restoration work is having on these fish, other wildlife, and the ecosystem. She coordinates ecological monitoring of the Penobscot River Restoration Project, manages collection of road-stream crossing data, and conducts a myriad of public outreach, education, and citizen science efforts including organizing and garnering support of World Fish Migration Day. Molly earned her Bachelor of Science from the State University of New York College of Environmental Science and Forestry, and her Master of Science at the University of Southern Maine where she applied otolith microchemistry techniques to infer fish habitat use.

8:30AM – 8:55AM

Alice R. Kelley, Roger LeB. Hooke
School of Earth and Climate Sciences and Climate Change Institute, University of Maine, Orono, ME; akelley@maine.edu; rogerhooke@gmail.com

The Penobscot River: From Glaciers to a Modern River

This paper uses geological and archaeological research to explore the linkage between geomorphology and human settlement of the Penobscot River. Landscape analysis suggests a pre-glacial, "ancestral" Penobscot River that was reborn with the recession of the Laurentide ice sheet. Isostatic depression first created an ocean embayment across the Penobscot Lowland during glacier retreat. As the land rose isostatically, the river re-established a course, creating a watershed that included today's drainage and that of Moosehead Lake. Glacial meltwater created a high velocity, sediment-laden river, and early cold and dry conditions promoted the formation of sand dunes. At approximately 10 ka, land level adjustment shifted the outlet of Moosehead Lake from the Penobscot watershed into the Kennebec River, decreasing the Penobscot 's discharge. Changing flows and sediment loads related to climatic variations alternately created terraces and exposed bedrock falls and rips. The stepped profile and generally sediment-poor nature of the Penobscot Lowland reach is a result of this history. Indigenous peoples' use of the region was linked to the development of the river and landscape. Earliest archaeological evidence in the valley dates to the early Holocene, although the river and surrounding water-rich landscape likely provided resources and a pathway for earlier post-glacial occupants. Use of the main stem and tributaries intensified as regional drainage patterns became more established, and a varied mosaic of resources combined with integrated stream networks helped to create a culture that persists to present. The arrival of Europeans marked a changed river through dam construction and industrialization.

Session 1 - Recovery of the Penobscot River

9:00AM – 9:25AM

Daniel H. Kusnierz
Water Resource Program Manager, Penobscot Indian Nation, Indian Island, ME; dan.kusnierz@penobscotnation.org

The Healing of a River: Changes in Penobscot River Water Quality Over the Past 25 Years

The Penobscot River, home to the tribe that shares its name, has for thousands of years provided sustenance through fishing, hunting, and the gathering of plants for food and medicines. The relationship between the tribe and the river is inseparable. Throughout the 1900s the river experienced much neglect with water quality impacts from logging, dams, untreated effluent, and industrial pollution from paper mills. This presentation will discuss the water quality improvements measured and witnessed by the Penobscot Nation's Water Resources Program staff over the past ~25 years. Some of the improvements include reductions in point source loadings, decreases in phosphorous levels, lack of episodic algal blooms, reductions in foam and color from industrial sources, decreased levels of dioxin in fish tissues, attainment of dissolved oxygen and bacteria criteria, upgrades in water classifications, and changes to benthic aquatic insect communities. The presentation will also discuss changes that occurred after the removal of two dams in the lower Penobscot River.

9:30AM – 9:55AM

Catlin Ames (student)[1], Micheal Kinnison[2], Joseph Zydlewski[3,4] Gayle Zydlewski[5]
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Recovery of an Historic Resource: Shortnose and Atlantic Sturgeon Abundance in the Penobscot River

Atlantic (*Acipenser oxyrhynchus*) and Shortnose sturgeon (*A. brevirostrum*) are anadromous species listed as threatened and endangered, respectively, in the Penobscot River. Historically, these species were a significant resource of meat to the Penobscot Nation, and to European settlers in the region. Their abundance began to decline with the onset of industrialization due to overharvest for caviar, and loss of habitat connectivity through dam construction. A moratorium was placed on all harvest by 1998 after the fishery collapsed. Recovery objectives included estimation of population sizes of the species, but was challenging as both species make extensive movements between river systems in the Gulf of Maine. To generate biologically realistic estimates of abundance in the Penobscot River, we have combined mark-recapture methods with acoustic telemetry analysis. For the last decade, gill netting surveys resulted in the capture and unique marking of 1,453 Shortnose and 224 Atlantic sturgeon with 433 and 21 recaptures, respectively. Approximately ten percent of all individuals were implanted with acoustic telemetry tags. Passive telemetry was used to estimate immigration/emigration rates, allowing the delineation of open and closed periods for robust maximum likelihood abundance estimation. Associated changes in demographic measures were also explored, including condition and growth of recaptured individuals. Population estimates suggest a stable to positive trend in population size in the river, with slow recovery likely due to late maturation and long life histories. The trend of abundances of these populations likely reflects their response to management actions such as fishery closure and dam removals.

Session 1 - Recovery of the Penobscot River

10:00 – 10:25PM

Samuel G. Roy[1], Adam Daigneault[2], Sean M.C. Smith[1,3], Shaleen Jain[4]
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A Data-Driven Approach to Planning River Barrier Decisions in the Penobscot River, Maine

Mainers have relied on tens of thousands of culverts to connect their communities through public and private roads for over a century. As these culverts age and degrade they become more likely to fail and cause damage to roadways and property. Many older culverts are now undersized for increasingly larger floods and bank erosion caused by climate and land use changes. Maine is also home to many aging dams that have long outlived their original purposes and now pose similar failure risks. Many of these underperforming river barriers prevent sea-run fish from reaching spawning and rearing habitat, cascading negative impacts into freshwater and marine ecosystems in ways that also diminish cultural, sustenance, and economic values in local communities.

We test a multi-objective machine learning approach to identify river barrier decisions that may lead to improvements in river ecosystem connectivity and infrastructure safety in the Penobscot River basin. A third objective is used to minimize the cost of culvert replacement and dam removal/modification because these decisions are expensive and challenging to exact within limited budgets of practitioners. Using our approach, we explore several coordinated decisions that may provide significant improvements in ecological connectivity and infrastructure safety at different budgetary levels. We find the number of barriers included in the assessment influences potential improvements and budget sizes, with larger-scale decisions providing overall greater improvements at lower cost. Finally, we explore the logistical challenges of coordinating these decisions, including needs for broad stakeholder engagement, restoration interests, local regulatory requirements, and private ownership.

Session 2 (Morning Session)

Sustainable Practices and Decision-Making Across Diverse Food Systems in Maine

The development of sustainable food systems in a changing climate and evolving globalized society is an ever more critical challenge. Food systems of production, distribution and consumption are embedded within issues of access, equality, sovereignty and justice that affect producers and consumers alike. Food producers attempt to harvest and distribute their products sustainably while trying to remain competitive within their markets, as consumers strive to purchase more locally-sourced foods in affordable and convenient ways. Across food systems in Maine, work is being done to better understand these systems and address current challenges. Drawing upon diverse disciplines, industries, and stakeholders, this session will look at the intersection of scale and sustainability as well as highlight some of the present work, progress, and applied solutions within the broader local food movement in Maine to achieve a more sustainable food system.

** 2 credits are available for this session through APA AICP*

Session Overview

8:30AM – 8:55AM Scott Vlaun
Climate Change and Regional Food Security

9:00AM – 9:25AM Cassandra Miller (student)
Alternative Treatment for a Chronic Disease of Small Ruminants, Caseous Lymphadenitis

9:30AM – 9:55AM Skye Siladi (student)
Sustainability in the Maine Maple Sugaring Industry: How Alternative Forms of Wealth are Conceptualized by Producers

10:00AM – 10:25AM Brianna Bowman, Jim Hanna, Scott Vlaun, Kelly Davis, Ken Morse
Community Food Councils as Vessels for Coordinated Food System Change

Session 2 - Diverse Food Systems in Maine

Session Chair

Sara Velardi
School of Forest Resources, University of Maine, Orono, ME; sara.velardi@maine.edu

Sara Velardi is a postdoctoral research associate in the School of Forest Resources at the University of Maine. She is currently working on a project to understand challenges and opportunities facing the small- to medium-sized maple syrup and beekeeping industries in the state of Maine to help support their continued sustainability and viability into the future. She received her Ph.D. in Environmental and Natural Resources Policy from SUNY College of Environmental Science and Forestry in Syracuse, New York, studying genetically modified organism (GMO) labeling initiatives in the U.S. Her research interests include social conflicts surrounding biotechnology in the food system, agrifood policy development and sociology of local, sustainable agriculture.

8:30 – 8:55AM

Scott Vlaun
Executive Director, Center for an Ecology-Based Economy, Norway, ME; scott@ecologybasedeconomy.org

Climate Change and Regional Food Security

With its deep reliance on fossil fuels, ongoing tillage, and continuing deforestation, the international food system is one of the main drivers of global warming, contributing up to one third of global greenhouse gas emissions. This food system is also extremely vulnerable to the climate instability caused by global warming, especially extreme weather events and protracted drought which exacerbate soil erosion, aquifer depletion, pollution of waterways, and ecosystem degradation. All this while failing to feed a hungry world.

The food system also holds the promise to help mitigate global warming while adapting to a changing climate through transitioning to agricultural practices that sequester carbon in soils and tree crops, with the bonus of producing healthier, more nutrient dense food in a more biodiverse, localized system. This presentation represents extensive research into the environmental and climate impacts of the industrial food system in the United States as well as its vulnerabilities. More importantly, it features working examples of cold-climate food production, mostly from the upper midwestern U.S., that demonstrate regenerative agriculture practices at a commercial scale that can be adapted to Maine's landscapes and climate.

The presenter makes the case for bio-regionally based research into appropriate regenerative agricultural practices that can increase regional food security, be replicable within limits, and address the climate crisis, while decreasing our dependence on non-renewable fossil fuels to feed a growing population.

9:00 – 9:25AM

Anne Lichtenwalner[1,2], Ann Bryant[1], **Cassandra Miller** (student)[1], Sarah Paluso[1]
1 University of Maine School of Food and Agriculture, Orono, ME; anne.lichtenwalner@maine.edu; ann.bryant@maine.edu; sarah.paluso@maine.edu
2 University of Maine Cooperative Extension, Orono, ME

Alternative Treatment for a Chronic Disease of Small Ruminants, Caseous Lymphadenitis (CL)

Caseous lymphadenitis (CL) is a chronic bacterial infection of small ruminants (sheep, goats and camelids) caused by *Corynebacterium pseudotuberculosis* (C.psTB). Maine has many small ruminant flocks, most of which consist of

fewer than 100 animals. During 2008 in Maine, multiple cases of abscesses in small ruminants, including internal abscesses in alpacas, were found; these were consistent with the clinical presentation of CL. This organism is persistent both in the environment and in the host immune system, and may cause superficial or internal abscesses. Due to the persistent nature of this pathogen, small farm owners may need to use treatments of animals and environmental surfaces to eradicate this organism from the farm, as well as culling infected animals. Due to changes in availability of antibiotics for farm use, increasing awareness of curtailing antibiotic use to reduce the incidence of antibiotic resistance in microbial pathogens, and a general movement toward organic methods in farming, finding alternative ways of eradicating C.psTB is of interest. Our lab utilized rosemary (*Rosmarinus officinalis)* oil emulsions to evaluate C.psTB sensitivity in vitro. Preliminary results indicate that this essential oil is effective against C.psTB at relatively low concentrations. Utilization of a spray emulsion in agricultural settings (feeders, barns) where small ruminants are housed may be a feasible means of disinfecting using organic methods. Alternatively, compounds that are found to be effective in vitro will be tested using cell culture and in vivo to assess safety and efficacy against this common threat to small ruminant health.

9:30 – 9:55AM

Skye Siladi (student)[1], Cynthia Isenhour[1,2], Jessica Leahy[3], Sara Velardi[3], Kourtney Collum[4], Melissa Ladenheim[5], Julia McGuire[6]

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Sustainability in the Maine Maple Sugaring Industry: How Alternative Forms of Wealth Are Conceptualized by Producers

Why do people farm? The answers are increasingly unclear given the heightened pressure of agricultural consolidation among small family farms. Understanding the sustainability of this industry requires looking beyond monetary factors– particularly the social and cultural ties within and among communities that inspire people to remain in a profession which may not be as lucrative as it once was. This presentation explores conceptualizations of social, cultural, and natural wealth as rationales for continuing in agricultural work, by focusing on maple syrup producers in Maine. At the small and medium-scale, maple syrup production cannot provide substantial income and yet people continue to participate in a time- and labor-intensive activity with marginal returns. Therefore, we argue that maple sugaring makes an interesting case study through which to explore the sustainability of small-scale agricultural endeavors with minimal financial benefits. Drawing on 10 semi-structured interviews with both multigenerational and first-generation maple syrup producers in Maine this presentation explores the reasons these producers have chosen to continue or begin maple syrup production, focusing on how the social connections, family history, cultural influence, and ecological factors have influenced their decisions surrounding their business. We argue that monetary considerations are not the primary factor in maple producers' decisions, rather that there is an array of motivations which suggest that their gains are linked to the intrinsic value in people, human relationships, and connections to culture and place, and that the sustainability of maple sugaring is linked to these alternative forms of wealth.

Session 2 - Diverse Food Systems in Maine

10:00 – 10:25AM

Brianna Bowman[1], **Jim Hanna**[2], **Scott Vlaun**[3], **Kelly Davis**[4], **Ken Morse**[5]

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5 Network Resource Advisor, Maine Network of Community Food Councils; kenmorse@mac.com

Community Food Councils as Vessels for Coordinated Food System Change

Throughout Maine, Community Food Councils are advancing locally responsive food systems change that prioritizes some of the most critical aspects of a just and sustainable food future for our state. This talk will highlight three councils and their work on racial equity, regenerative agriculture, and waste reduction. Participants will learn about these individual efforts and how they are woven together into a coordinated and mutually supportive movement by the Maine Network of Community Food Councils (MNCFC).

The Center for Ecology Based Economy will share about intersections of agriculture and climate change, and their work to bring regenerative agricultural practices to Norway, Maine, through the establishment of a permaculture food forest and community composting program at the Alan Day Memorial Garden.

The Cumberland County Food Security Council will discuss how their work addresses anti-racism, and the efforts they have taken to raise awareness about structural racism by facilitating the Racial Wealth Gap Learning Simulation. The Simulation is an interactive tool developed by Bread for the World that helps people understand the connections among racial equity, hunger, poverty, and wealth.

The Merrymeeting Gleaners will share their work to redirect over 40,000 lbs of surplus and "ugly" food products to food security organizations, by working with local farms and producers to take excess food from the fields or farmers' markets and deliver it to local food pantries, Head Start/WIC programs, and low-income communities.

Session 3 (Morning Session)

Climate Change Policy – Local and National Perspectives

This session will cover various aspects of climate change policy, including talks related to coastal adaptation in regard to sea level rise, the effects of climate change on Maine's lakes and strategies for adaptation, national-level policy initiatives to reduce CO_2 emissions, and the potential costs of inaction on climate change as it applies to Maine.

** 2 credits are available for this session through APA AICP*

Session Overview

8:30AM – 8:55AM Robert Faunce
Sea Level Rise: Impacts and Planning for Resilience in Coastal Lincoln County

9:00AM – 9:25AM Danielle Wain, Whitney King, Peter Kallin
Early Indications of Climate Impacts on Maine Lakes: A Case Study from the Belgrades

9:30AM – 9:55AM Michael Jones
The Energy Innovation and Carbon Dividend Act and Its Implications for Climate Change Mitigations

10:00AM – 10:25AM Staff, Office of Senator Collins
Increasing Federal Disaster Recovery Costs Due to Climate Change

Session Chairs

Peter Garrett
Coordinator, Citizens Climate Lobby in Maine; petergarrett.sgg@gmail.com

Emily Green
Staff Attorney, Conservation Law Foundation, Portland, ME; egreen@clf.org

Peter Garrett is an earth scientist by training, and a retired hydrogeologist by profession. He is now the coordinator of Citizens Climate Lobby (CCL) volunteers in Maine, advocating a bipartisan revenue-neutral plan to cut carbon emissions by pricing carbon fuels, called Carbon Fee & Dividend.

Session 3: Climate Change Policy

Emily K. Green is a Staff Attorney with Conservation Law Foundation, a regional organization dedicated to forging lasting solutions to environmental challenges for the people of New England. Emily works out of Portland, Maine, where her practice focuses on reducing greenhouse gas emissions from the energy and transportation sectors by focusing on renewable generation, climate change policy, and energy efficiency.

Prior to joining CLF, Emily provided comprehensive legal services to Maine's Department of Environmental Protection as an Assistant Attorney General. Previously, she represented survivors of domestic violence while working for a nonprofit organization in southern Maine.

8:30 – 8:55AM

Robert Faunce
County Planner, Lincoln County Regional Planning Commission, Wiscasset, ME; rfaunce@lcrpc.org

Sea Level Rise: Impacts and Planning for Resilience in Coastal Lincoln County

While some may quibble about the causes of climate change, it is undisputable that sea level is rising, both worldwide and in Maine. The increase in sea level along Maine's coast was relatively constant but modest until the last 20 years or so. We have now entered a period where sea level is rising at rates never previously experienced and even conservative projections for future increases are breathtaking.

Lincoln County has between 450 and 640 miles of tidal coastline, depending on the source and how islands and estuaries are counted. Sixteen of the county's nineteen communities and its four wastewater treatment facilities are threatened by rising seas to varying degrees. Using funds awarded under the Maine Coastal Program's Coastal Community Grant Program and the Department of Marine Resources' Shore and Harbors Program, sea level rise impact studies have been completed or are now in process for Damariscotta and Boothbay Harbor downtowns, Monhegan Island and the Wiscasset and Boothbay Harbor wastewater treatment plants and pump stations. In addition, sea level rise considerations have been included in the planning processes for improvements to the Boothbay Harbor Fish Pier, the Monhegan Island Breakwater, Damariscotta municipal parking lot and the Wiscasset Recreational Pier. However, costs have been, and continue to be, major impediments to implementing many commonsense recommendations for improving the resilience of coastal communities and infrastructure to rising seas.

9:00 – 9:25AM

Danielle J. Wain[1], **D. Whitney King**[2], **Peter L. Kallin**[1]
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Early Indications of Climate Impacts on Maine Lakes: A Case Study from the Belgrades

Climate change is expected to have a variety of impacts on the world's freshwater resources. Maine's lakes are no exception. Warmer and longer summers will change patterns of stratification, increasing in strength in lakes that already stratify, and leading to stratification in lakes that previously remained well mixed through summer. This is likely to increase anoxic periods and lead to anoxia in lakes that are usually well oxygenated, which in turn will result in more release of phosphorus from lake sediments. Increased storm events will increase phosphorus loads from the watershed.

Warmer waters and high phosphorus levels are ideal for nuisance blooms of cyanobacteria, reducing the value of lakes for recreation and potentially releasing toxins into the water. Warmer and longer summers will also increase

Session 3: Climate Change Policy

the habitable range of some invasive species, as well as reducing the effectiveness of Courtesy Boat Inspections in reducing transmission of invasives as more boats enter the water outside the traditional Memorial Day-Labor Day summer period. Because of the variety of lake characteristics found in the Belgrades, all experiencing the same climactic impacts, the Belgrade Lakes provide an ideal setting to examine early indications of such impacts on Maine's lakes as well as to develop and test potential mitigation strategies and practices, such as changes to culvert specifications, increasing the width and biodiversity of riparian buffers, or changing fisheries management strategies.

9:30 – 9:55AM

Michael Jones
Professor Emeritus on Economics, Bowdoin College, Brunswick, ME; mjones@bowdoin.edu

The Energy Innovation and Carbon Dividend Act and Its Implications for Climate Change Mitigation

The Energy Innovation and Carbon Dividend Act was introduced into both the House and Senate and Congress in late 2018. By the start of this Sustainability and Water Conference it is expected to have been reintroduced in the 116th Congress. When enacted this policy will be effective in reducing America's emissions at least 40% within 12 years. It will be good for people in that it will improve health and save lives. Additionally, the carbon dividend puts money directly into people's pockets every month to spend as they see fit, which is especially helpful for low- and middle-income Americans. It will be good for the economy, creating 2.1 million additional jobs over the next 10 years, thanks to growth in the clean energy economy. It is bipartisan legislation, which is important because solving climate change is too urgent to get caught in partisan politics. It is revenue-neutral, with the fees collected on carbon emissions allocated to all Americans to spend any way they choose. The government will not keep any of the carbon fees collected.

10:00 – 10:25AM

Staff (TBA)
Office of Senator Collins

Increasing Federal Disaster Recovery Costs Due to Climate Change

In the wake of the severe hurricanes of 2017, the multi-year drought, interspersed with torrential rains across the west, and the wildfires in nine western states, the Government Accountability Office (GAO) published a new report requested by Senators Susan Collins (R-ME) and Maria Cantwell (D-WA) on the economic impacts of climate change. The final tally in economic losses from 2017 events exceeded $300 billion. The GAO report states that the number and intensity of these extreme weather events will rise, costing taxpayers more than $1 trillion by 2039. If hurricane and wildfire seasons continue in a similar pattern to 2017, costs will exceed $6 trillion in 20 years.

Session 4 (Morning Session)

Clean Water Careers: A Review and Discussion of the Opportunities in Maine

A review of the careers available in Maine (wastewater, stormwater, drinking water), including the changing nature/new career opportunities associated with protecting Maine's waters, particularly those involving newer technologies and data systems. The session will include a panel discussion with Young Professionals who are new to the industry and more veteran water professionals.

** This session have been approved for 2 training contact hours (TCH) through Maine's Wastewater Operator Certification Program*

Session Chair

Paula Drouin

Maine Water Environment Association, Augusta, ME; pdrouin@lawpca.org

Paula Drouin is the Lab Supervisor at the Lewiston-Auburn Water Pollution Control Authority. She holds a Bachelor's Degree in Natural and Applied Sciences and a Master's Degree in Biology. Paula has been involved with the Maine Water Environment Association (MEWEA) for over ten years, where she started the Young Professionals Committee in 2011, and then went on to develop and manage MEWEA's social media accounts. Most recently, she served as MEWEA President (2018).

8:30 – 8:55AM

Curtis Bohlen

Director, Casco Bay Estuary Partnership, Portland, ME; curtis.bohlen@maine.edu

In 2017, Casco Bay Estuary Partnership (CBEP) convened the Casco Bay Nutrient Council to provide a forum for examining the impact of nutrient pollution on Casco Bay, and identifying effective and cost-effective strategies to address the problem. The Council has met six times over two years to review the state of the science, identify innovative approaches to reducing nutrient pollution, or inventory existing efforts, and develop recommendations. Join this session to learn about what has been learned and what questions, challenges and work we still face moving forward.

Session 4: Clean Water Careers

9:00 – 9:25AM

Emily Zimmermann
Biologist, Marine Unit, Maine Dept. of Environmental Protection, Augusta, ME; emily.zimmermann@maine.gov

Travel! Adventure! Making a difference! No. It's not the military! Join us in an overview of opportunities working with the Maine Department of Environmental Protection (DEP). Charged with the responsibility of enforcing the state's environmental laws and protecting and restoring Maine's natural resources, the DEP engages in a wide range of activities across the entire state of Maine. Focus will be on the Bureau of Water Quality's Division of Environmental Assessment. Responsible for most of DEP's scientific monitoring and assessment, our biologists, geologists, and water specialists conduct extensive field work in, on, over and even under all water body types, including groundwater. This talk will share the wide variety of activities in which the staff engages, all for the purpose of protecting or restoring Maine's water resources.

9:30 – 10:25AM

Panel Discussion

This panel discussion will include participation from Maine Water Environment Association (MEWEA) Young Professionals and others who have been in the water industry long-term. What has changed over the years and what new opportunities exist in Maine?

Panelists
Jordon Heath, Asset Management Technician, City of Portland, Portland, ME
Scott Firmin, Director of Operations – Wastewater, Portland Water District
Gretchen Anderson, Environmental & Sustainability Coordinator, Town of Windham
Maxwell Kenney, Engineer, Woodard & Curran
Cassidy Wallitsch, Engineer, Woodard & Curran

Session 5 (Morning Session)

The Importance of Long-Term Data for Understanding Water-Related Issues in Maine

Long-term data collection is critical for understanding the average conditions, variability, and trends of natural systems. Many organizations have collected water-related data in Maine to help inform specific issues and this data is often relevant to other issues. We invite talks on how long-term data collection has helped inform societally relevant water issues. This could include precipitation, streamflow, snow pack, groundwater levels, water quality, and other data.

** Three presentations in this session have been approved for training contact hours (TCH) through the State of Maine Board of Licensure of Water System Operators. Please see below for details.*

Session Overview

8:30AM – 8:55AM Margaret Burns, Amana Gavin (0.5 TCH)
Observations of Physical Parameters from Continuous Monitoring in Watchic Lake in Standish, Maine

9:00AM – 9:25AM Daniel Locke (0.5 TCH)
The Maine Cooperative Snow Survey: A Multi-Agency Effort with Multi-Disciplinary Applications

9:30AM – 9:55AM Brooke Hafford MacDonald (student)
Lead Poisoning in Maine's Common Loons: Examining Biological and Social Dimensions

10:00AM – 10:25AM Mark Dubois, John Rand (0.5 TCH)
Sustainable Water Policy and Practice – The Long-Term Monitoring Program at Cold Spring, Denmark

Session Chair

Nicholas Stasulis
Data Section Chief, USGS New England Water Science Center, Maine Office, Augusta, ME; nstasuli@usgs.gov

After graduating from the University of Maine, Nick has spent the last 16 years collecting streamflow, groundwater and water quality data in Maine with the U.S. Geological Survey. During that time, Nick had a particular interest in the use of hydroacoustics for measurement of streamflow in open water and under-ice conditions, and teaches

classes on the topic nationally. Since 2016, Nick has served as the Hydrologic Surveillance Chief for the Maine Office of the New England Water Science Center.

8:30 – 8:55AM

Margaret Burns, Amanda Gavin, Forrest Bell
FB Environmental Associates, Portland, ME; margaretb@fbenvironmental.com; amandag@fbenvironmental.com

** Approved for 0.5 TCH*

Observations of Physical Parameters from Continuous Monitoring in Watchic Lake in Standish, Maine

Watchic Lake is a 443-acre lake located in the Town of Standish, Maine. Water quality monitoring is donation sponsored and implemented by volunteers. Although Watchic Lake water quality is currently good, it may be at risk due to development in the watershed. Since 2016, the Watchic Lake Association (WLA) has been working with FB Environmental Associates (FBE) of Portland, Maine to continuously monitor water quality. Each summer, a buoy with continuous data loggers suspended at each meter is deployed at the lake's deep spot. Three data loggers monitor both dissolved oxygen and temperature (deployed at 2 meters, 5 meters, and 11 meters from the surface), and the remaining meter intervals have data loggers that measure only temperature. Beginning in the 2017-2018 season, temperature data loggers remained deployed through the winter, providing year-round, continuous temperature data. This data has allowed the WLA and FBE to monitor the vertical extent and duration of dissolved oxygen depletion at the bottom of the lake and the exact dates of spring and fall turnover. Additionally, it provides a window into winter lake dynamics, a critical component of a lake's physical response to climate change. Moving forward, the WLA is developing a watershed protection plan to identify (and hopefully remediate) likely sources of nonpoint source pollution that could be contributing to oxygen depletion. This presentation will explore what the project partners have learned and how it can be used to monitor water quality responses to changes in pollutant load, local weather patterns, and regional climate change.

9:00 – 9:25AM

Daniel Locke[1], Amber Whittaker[1], Christian Halsted[1], James Caldwell[2], Marc Loiselle[3]
1 Maine Geological Survey, Augusta, ME; daniel.b.locke@maine.gov
2 U.S. Geological Survey, New England Water Science Center, Maine Office, Augusta, ME
3 Maine Geological Survey (Retired), Readfield, ME

** Approved for 0.5 TCH*

The Maine Cooperative Snow Survey: A Multi-Agency Effort with Multi-Disciplinary Applications

Driven by the water management information needs of different agencies, a long-term, nearly continuous record of snow depth and its associated water content has been collected in Maine. The first headwater snow surveys were conducted in the early 1900s by dam operators seeking to regulate reservoir storage capacity. From that time until the mid-1980s snow data was collected at selected sites around Maine by the National Weather Service (NWS) and the U.S. Geological Survey (USGS), in cooperation with the State of Maine. Spring flooding in 1983 spurred formation of the River Flow Advisory Commission (RFAC) to facilitate the exchange and review of hydrologic information, such as snow pack, and to provide information to emergency management agencies and the public. The RFAC administers the current Maine Cooperative Snow Survey, which is a partnership between the USGS, the

Session 5: The Importance of Long-Term Data

Maine Geological Survey (MGS), and many other contributors. Each season, snowpack depth and water content data are collected at established sites from early January until the sites are snow-free. The data are compiled, reviewed, and analyzed by the USGS and MGS, and used to produce statewide maps and datasets that are published on the RFAC website. All available snow survey data have been compiled by the USGS and MGS and reside in a publicly-available database managed by MGS. This presentation will review the history of Maine snow data, snow data collection methods, map and data products from the Maine Cooperative Snow Survey, and current and possible future uses for the data.

9:30 – 9:55AM

Brooke Hafford MacDonald (student)[1], Sandra de Urioste-Stone[2], David Evers[3], Brian Olsen[4]
1 Ecology and Environmental Sciences, University of Maine, Orono, ME; brooke.hafford@maine.edu
2 School of Forest Resources, University of Maine, Orono, ME
3 Biodiversity Research Institute, Portland, ME
4 School of Biology and Ecology, University of Maine, Orono, ME

Lead Poisoning in Maine's Common Loons: Examining Biological and Social Dimensions

Lead poisoning from ingested fishing tackle is a well-documented conservation concern for adult common loons in the Northeastern U.S. To mitigate this issue, the state of Maine has enacted legislation banning certain types of lead tackle beginning in 2002. In addition to legislative action, there have been various non-regulatory strategies employed in Maine to help raise awareness. However, policy and outreach initiatives have been met with controversy and some residents argue against regulations. Human behavior is the root cause of lead fishing tackle in aquatic environments and can determine the success of legislative and educational campaigns. Therefore, in order to understand the efficacy of these efforts, we developed an interdisciplinary study with two overarching goals: (1) to document the number of adult common loon mortalities resulting from lead poisoning; and (2) to measure factors that influence attitudes and behaviors of Maine residents regarding lead tackle use. We began by analyzing a long-term dataset containing information for over 2,000 common loon necropsies conducted in the Northeastern U.S. between 1987 and 2016. In 2016, we surveyed Maine residents about their lead tackle use. Our primary findings were that lead mortality in Maine's adult common loons has decreased over time, and anglers reported using lead fishing tackle less frequently over the last five years. The 30 years of necropsy data were an invaluable resource necessary to determine rates of mortality over time, particularly before and after legislative implementation.

10:00 – 10:25PM

Mark Dubois[1], **John Rand**[2]
1 Poland Spring, Poland, ME; mark.dubois@waters.nestle.com
2 John Wood Group, Portland, ME; john.rand@woodplc.com

** Approved for 0.5 TCH*

Sustainable Water Policy and Practice – The Long-Term Monitoring Program at Cold Spring, Denmark, ME

Cold Spring is located in a sand and gravel aquifer in Denmark, Maine. Water from Cold Spring provides a source for bottled spring water products for Poland Spring/Nestle Waters North America. Spring conditions suitable for development as a commercial spring site were researched in the early 2000's. Along with spring development, the

Session 5: The Importance of Long-Term Data

Town of Denmark enacted a Water Extraction Ordinance in 2005, which has since been amended twice, and includes third-party data review by the Town of Denmark's hydrogeologist.

Cold Spring is regulated by multiple governmental agencies, including as a public water system by the Maine Drinking Water Program, a significant groundwater well by the Maine Department of Environmental Protection, and a large-scale water extraction by the Town of Denmark. Because the water is a food product, it is also subject to the U.S. Food and Drug Administration's requirements for spring water.

From these local, state and federal rules pertaining to spring water withdrawal and use in a food product, Poland Spring and Wood PLC operate a system of long-term data collection, analysis and reporting on the sustainability of the spring and associated aquifer.

Altogether, the established water monitoring program represents a case study of sustainable water policy and practice in Denmark. To be a sustainable operation, public interpretation of water data are important. Tools used to relate long-term data trends to the public represent important learnings within the context of sustainability and public policy regarding water withdrawal at Cold Spring.

Session 6 (All-Day Session)

Native Alewife Restoration and Lake Water Quality

Concerns have been raised that restoration of native alewife runs to eutrophic lakes may exacerbate algae blooms and reduce water clarity. Two supposed mechanisms are offered. First, juvenile alewives are efficient consumers of the largest zooplankton which are themselves efficient consumers of suspended algae. A depleted zooplankton population may temporarily leave more nuisance algae in the water column, which reduces water clarity. Second, there are fears that spawning adult alewives may introduce more marine-derived nutrients to already overly fertile ponds than out-migrating juveniles can carry away in their bodies. Data from various Maine lakes show no clear relationship between the presence of native alewives and water clarity. Phosphorus budget studies suggest that low escapement may mitigate or reverse phosphorus loading impacts. In the absence of scientific consensus, public natural resource agencies have staked out opposing positions which may stall efforts to reconnect fragmented ecosystems.

Public discussion among researchers and resource managers will clarify research goals to determine optimum escapements and management strategies for restoring extinguished alewife runs while mitigating unwanted water quality impacts.

Session Overview

8:30AM – 8:55AM William G. McDowell
Assessing the Impacts of Reintroducing Alewives: Lessons from Ecological Theory and Existing Research

9:00AM – 9:25AM Karen Wilson
Top Down vs. Bottom Up Effects of Searun Alewife on Lake Phytoplankton Dynamics: A Case Study of Highland Lake, Maine

9:30AM – 9:55AM Betsy Barber
Exploring How a Range of Management Objectives Could Affect Alewife Population Recovery

10:00AM – 10:25AM Matthew T. Devine (student)
Factors Affecting the Density and Growth of Juvenile River Herring: Insights from 32 Coastal New England Freshwater Lakes

1:30PM – 1:55PM Mike Brown, Gail Wippelhauser, Nate Gray
River Herring Ecology and Select Maine Lakes

Session 6: Native Alewife Restoration

2:00PM – 2:25PM Barry Mower
Effect of Anadromous Alewives (Alosa pseudoharengus) on Water Quality of Some Maine lakes

2:30PM – 3:00PM Break (Auditorium)

3:00PM – 4:00PM Panel Discussion

Session Co-Chairs

Richard Behr
Retired hydrogeologist, Maine Dept. of Environmental Protection; richardsbehr@gmail.com

John E. Beane
Retired hydrogeologist, Maine Dept. of Environmental Protection; kennebecus@yahoo.com

Richard Behr studied geology and chemistry at the University of Maine at Farmington before completing an M.Sc. program in Biogeochemistry at Canada's premier limnologic research station: The Experimental Lakes Area. After graduation, Richard returned to Maine where he worked as a hydrogeologist for the Maine Dept. of Environmental Protection. As a result of his lifelong enthusiasm for Maine's rivers and lakes and a career as an environmentalist, Richard has participated in a variety of fishery restoration projects throughout Maine. Involvement in projects to restore Maine's diadromous fish populations have been particularly important to Richard's appreciation and understanding of the role these fish play in a healthy ecosystem. As a registered Maine fishing guide, Richard has firsthand experience of the importance of fishery restoration. Richard and his wife live on the free-flowing section of the Kennebec in Vassalboro, Maine.

John Beane grew up in Gorham fishing the impounded Presumpscot. He graduated from the University of Southern Maine (earth science) and moved west for a Masters and Ph.D. in geology. John's dissertation was on the flow stratigraphy and petrogenesis of the Deccan Flood Basalts of western India. He retired last year after 28 years doing hydrogeology at the Maine Dept. of Environmental Protection, and now spends spare time advocating for fish passage on Cobbossee Stream with the non-profit group Upstream.

8:30 – 8:55AM

William G. McDowell
Department of Biology, Merrimack College, Andover, MA; mcdowellw@merrimack.edu

Assessing the Impacts of Reintroducing Alewives: Lessons from Ecological Theory and Existing Research

Alewives, (*Alosa pseudoharengus*), are an anadromous fish native to the eastern seaboard of the United States. As adults, they return from the ocean in late spring and early summer in order to reproduce in freshwater lakes, and juveniles remain in freshwater until late summer when they return to the ocean. Alewives were once abundant throughout Maine, though dams and other human impacts have led to dramatic declines and the extirpation of many populations, causing the species to be listed as a species of concern by the U.S. National Marine Fisheries Service. Anadromous alewives have been restored to many lakes throughout Maine, however there have been concerns about the impacts of alewives on water quality, as ecological theory indicates that alewives could lead to more algae via top down control of the food web, and bottom up impacts via the introduction of marine derived nitrogen and phosphorus. Research on Maine lakes has shown that the reintroduction of alewives has not led to negative impacts on water quality. Here, we explore exactly what is meant by top down and bottom up control of algae growth,

provide background on our current knowledge of the impacts of alewife reintroductions, and compare and contrast alewives to lessons from other trophic cascades and anadromous species such as salmon.

9:00 – 9:25am

Karen Wilson[1], Jeff Dennis[2], Linda Bacon[2], Meg Thurrell[3], Keith Williams[4]
1 Dept. of Environmental Science and Policy, University of Southern Maine, Portland, ME; karen.wilson@maine.edu
2 Lakes Division, Maine Department of Environmental Protection, Augusta, ME
3 Dept. of Biology, University of Southern Maine, Portland, ME
4 Highland Lake Association Water Quality Monitoring Team, Windham, ME

Top Down vs. Bottom Up Effects of Searun Alewife on Lake Phytoplankton Dynamics: A Case Study of Highland Lake, Maine

Searun alewife (*Alosa pseudoharengus*) are strong interactors in lake ecosystems through the import and export of nutrients, and through efficient consumption of zooplankton. In 2015-2018, mesotrophic Highland Lake (Windam & Falmouth, Maine) experienced significant drops in water clarity during July and August (Secchi depth ≤ 2 m) in years in which alewife numbers ranged from ~14-100 spawning adults/acre. Continuing development of housing subdivisions in the watershed spurred the Lake Association to instigate an intensive study of the lake to determine the cause(s) of the algal bloom responsible for reduced water clarity. Results from 2018, during which the bloom did not fully materialize, showed a strong, spatially distinct spike in total phosphorus associated with a persistent metalimnetic dissolved oxygen minima after water clarity began to recover. This spike in TP had been observed in epilimnetic composite samples in previous years after the bloom had occurred. Adult alewife reached a high of ~100 spawning fish/acre, and juvenile alewife were present in the lake as late as mid-October. Processing of zooplankton and phytoplankton samples for species abundance and composition is in progress, although the lake exhibited a strong reduction in larger zooplankton after the spring clearwater phase. Results from this case study highlight the complexity of alewife-lake ecosystem interactions and the productivity of strong collaborations between lake associations and limnologists.

9:30 – 9:55AM

Betsy Barber[1], Jamie Gibson[2], Andrew O'Malley[1], Joseph Zydlewski[1,3]
1 University of Maine, Dept. of Wildlife, Fisheries, and Conservation Biology, Orono, ME; betsy.barber@maine.edu
2 Fisheries and Oceans Canada, Science Branch, Maritimes Region
3 U.S. Geological Survey, Maine Cooperative Fish and Wildlife Research Unit, University of Maine, Orono, ME

Exploring How a Range of Management Objectives Could Affect Alewife Population Recovery

Many alewife populations in Maine have experienced recent increases in spawner abundance. We developed a population model using best available regional data to explore the theoretical influence of management actions in the St. Croix River. Specifically, we explored the influences of fish passage improvements, stocking of adult spawners, and commercial harvest. We conducted simulations for a range of adult passage rates (upstream and downstream) and juvenile downstream passage. The relative location of dams to spawning habitat within this watershed affected the scope of population recovery because of the multiplicative effects of dam passage. Low passage efficacy also reduced both the overall abundance expected in the run as well as truncating the age structure of the population (reduction of older age classes). Interestingly, the theoretical effect of a commercial fishery on population recovery

was strongly dependent on its location in the watershed relative to spawning habitat. We present this model as a tool that can be readily applied to other systems to inform local decision making by stakeholders.

10:00 – 10:25AM

Matthew T. Devine (student)
University of Massachusetts Amherst, Dept. of Environmental Conservation, Amherst, MA; mtdevine@umass.edu

Factors Affecting the Density and Growth of Juvenile River Herring: Insights from 32 Coastal New England Freshwater Lakes

Current management objectives for anadromous (searun) alewife, Alosa pseudoharengus include restoring the species to historic spawning habitats, yet favorable conditions are not well described. Additionally, although it is assumed that adult run size reflects juvenile productivity and vice versa, these relationships have not been formally tested. Without knowledge of the adult-juvenile relationship and an understanding of what constitutes ideal spawning and nursery habitats in lakes, prioritization of habitat restoration is limited. In this study, we investigate the influence of adult density on juvenile density and explore the extent to which landscape characteristics (lake size, land cover) and lake nutrients (nitrogen, phosphorous, dissolved organic carbon) influence juvenile growth. Using a newly developed lake sampling protocol for juveniles, and laboratory analysis of otoliths to determine age and growth rates, we observed large differences in density and growth both within and among lakes. Adult density explained 60% of the variation in juvenile density and this relationship was nonlinear. Dissolved organic carbon (DOC) explained additional variation in juvenile densities, with lower herring densities in lakes with elevated concentrations of DOC. Surprisingly, growth rates were not influenced by nutrient levels. Instead, the density of juveniles best predicted growth where low density (stocked) lakes exhibited higher growth rates (mean ±SE = 1.04 mm/day ±0.020) than higher density lakes (0.891 mm/day ±0.017), suggesting density dependent growth as a key mechanism. Incorporating these relationships into population models will improve predictions of recruitment and assist management decisions and habitat prioritization for this economically and ecologically important species.

1:30 – 1:55PM

Mike Brown, Gail Wippelhauser, Nate Gray
Maine Department of Marine Resources, Augusta, ME; michael.brown@maine.gov; gail.wippelhauser@maine.gov; nate.gray@maine.gov

River Herring Ecology and Select Maine Lakes

River herring (alewives and blueback herring) have direct and large impacts on regional ecologies in the freshwater (and marine) environment. The “Keystone species” aspect of their presence/absence will be discussed. A trophic cascade will be shown in which river herring are the keystone species. Several examples will be cited.

Session 6: Native Alewife Restoration

2:00 – 2:25PM

Barry Mower
Maine Department of Environmental Protection, Augusta, ME; barry.f.mower@maine.gov

Effect of Anadromous Alewives (*Alosa Pseudoharengus*) on Water Quality of Some Maine Lakes

Maine's water quality standards require that surface waters be suitable as habitat for fish and other aquatic life. Spawning areas are a critical part of habitat necessary to sustain fish populations. Anadromous alewives (*Alosa pseudoharengus*) are indigenous to many coastal aquatic systems with historic access to spawning grounds in lakes and ponds. In the last 100 years or so, many dams have been constructed that have eliminated access of alewives to their spawning grounds. Human development of lakes and pond shorelines and watersheds has caused an increase in the input of phosphorus and resulting algal blooms. Knowing that in a simple food chain, juvenile alewives consume zooplankton, which in turn consume algae, some lakeshore residents fear that the Department of Marine Resources program for reintroduction of alewives to their original spawning lakes and ponds will cause or exacerbate algal blooms. But lake and pond food webs are much more complex than theoretical simple food chains. The Dept. of Environmental Protection has conducted two extensive studies and has examined water quality data from several other lakes or ponds with alewives. While no two lakes or ponds are exactly alike, to date there are no data documenting an increase in algal blooms in lakes with alewives. To the contrary, if water levels allow emigration of adults and juveniles from lakes and ponds, there may be a net export of phosphorus to the extent that blooms or their potential are reduced. A current study of Highland Lake in Falmouth may further inform these issues.

2:30 – 3:00PM

Break – Auditorium

3:00 – 4:00PM

Panel Discussion

Panelists: *Bill McDowell, Karen Wilson, Betsy Barber, Matthew Devine, Mike Brown, Gail Wippelhauser, Nate Gray, Barry Mower*

The afternoon panel discussion will allow the session's speakers to elaborate on the some of the nuances of how alewife restoration potentially alters lake water quality and ecology. In addition to answering questions from the audience, the co-chairs anticipate the session's scientists will further illuminate how specific fisheries management strategies may enhance the benefits and reduce potential detrimental impacts alewife restoration may have on lake water quality.

Session 7 (All-Day Session)

Developing Effective Sustainability Curricula

In light of a myriad of environmental challenges, the need for high-quality undergraduate curricula on topics of sustainability has never been more urgent. This session showcases new or established courses, modules, and programs that are developed to educate and engage students to generate solutions out of sustainability problems. While the science of global change is critical to student understanding of this broad topic, we note that effective sustainability solutions must engage the expertise of the social sciences and humanities. As formats and teaching strategies, project-based experiences may engage students more deeply and empower them with the technical and social skills across disciplines that are necessary to navigate the challenging times ahead. However, co-teaching and interdisciplinary work poses many challenges for faculty, including coherent methodology across subject areas, unification of topics, work load, and others. Therefore, a priority of this session is to focus on effective development and implementation of courses and programs aimed to address the complex sustainability challenges our students will face in the critical decades that lie ahead.

Session Overview

Talks in this session are 15 minutes.

8:30AM – 8:45AM tish carr (student)
WaYS to Change Academic Paradigms

8:45AM – 9:00AM Brieanne Berry (student), Shayla Kleisinger (student), Taylor Patterson (student)
Co-learning Sustainability Science & Policy: An Interdisciplinary Approach to Food Waste Reduction

9:00AM – 9:15AM Donelle Schwalm
Conservation in the National Parks: Past, Present and Future

9:15AM – 9:30AM Douglas Reusch
Sink or Swim: A Foundation Course in Sustainability for All by All

9:30AM – 9:45AM Julia Daly
Mining in Maine? A Focus Topic for an Introductory Environmental Geology Course

9:45AM – 10:00AM Peter Hardy
Post-Apocalyptic Survivor: A Game to Examine the Consequences of Environmental Collapse

Session 7: Developing Effective Sustainability Curricula

10:00AM – 10:15AM Jesse Minor
Teaching Sustainability by Linking Environmental History and Political Ecology for Effective Field-Based Pedagogy

10:15AM – 10:30AM Susan G. Letcher
Restoration Ecology as a Framework for Teaching Sustainability

1:30PM – 1:45PM Susan E. Farady
Reinventing an Interdisciplinary Marine Affairs Curriculum for the 21st Century

1:45PM – 2:00PM Lucas C. Kellett
University Sustainability as a Teaching Tool: Applications from the University of Maine at Farmington

2:00PM – 2:15PM Lora Winslow, Ethel Wilkerson, Abigayl Novak (student)
Preparing the Next Generation: A Sustainability Curriculum Focused on Professional Development

2:15PM – 2:30PM Shawn Mercer, Maizey Mercer (student)
Guiding Learners Towards Authentic Leadership and Purpose

2:30PM – 3:00PM Break (Auditorium)

3:00PM – 3:15PM John Rooks
Teaching the Building of a Culture of Sustainability

3:15PM – 3:30PM Peter Cooke
Students Providing Sustainability Assessments for Sector Based Businesses

3:30PM – 4:00PM Discussion

Session Co-Chairs

Rachel Hovel
Assistant Professor of Biology, University of Maine at Farmington, Farmington, ME; rachel.hovel@maine.edu

Denise Bruesewitz
Assistant Professor of Environmental Studies, Colby College, Waterville, ME; dabruese@colby.edu

Dr. Rachel Hovel is an assistant professor at University of Maine at Farmington. She studies fishes and invertebrates across a range of freshwater habitats, and is particularly interested in how changes to freshwater environments–especially climate change–influence aquatic organisms and ecosystems. Her research takes place in Alaska, the Canadian Arctic, and the lakes of Maine and involves undergraduate researchers throughout. Mentoring and training in her lab emphasize preparing students to ask and address ecological questions in a world undergoing rapid change.

Dr. Denise Bruesewitz is an associate professor of environmental studies at Colby College. She studies eutrophication, nutrient cycles and algal bloom dynamics in freshwater and estuarine ecosystems. Her current research focuses on Maine lakes and coastal ecosystems in New York City. She seeks to incorporate undergraduate students in her research, including the co-development of the 'Northeast GLEON' collaborative network for scientists and students working in lakes across the northeast, and incorporating civic engagement into research and the classroom.

Session 7: Developing Effective Sustainability Curricula

Section A - Classroom Tools

8:30 – 8:45AM

tish carr (student)[1], Darren Ranco[2]
1 WaYS Program, University of Maine, Orono, ME; tish.carr@maine.edu
2 Native American Program, Dept. of Anthropology, University of Maine, Orono, ME

WaYS to Change Academic Paradigms

The past five years, the Wabanaki Youth in Science program (WaYS) has been the "bridge" for Native high school students to learn more about STEM (Science, Technology, Engineering and Math) fields at the high school level to help develop and implement programs to address the myriad of challenges to encourage place-based solutions to long-term sustainable issues for Native students. This has been done by integrating Wabanaki Ecological Knowledge (WEK) and western science in an outdoor, place-based education setting utilizing Cultural Knowledge Keepers (CKK) and western science resource professionals (WSRP). There has been a 15% increase in the number of Native Youth attending University of Maine, Orono in the science field over the last three years.Through a National Science Foundation grant, this successful model educational program is being expanded into post-secondary education.

Through partnership and inclusion of CKK into core curriculum within the School of Forest Resources forest management classes and the College of Engineering hydrology class, CKK and WSRP work together to include WEK and western science into current curriculum. The goal is to change the academic paradigm to create a different model of communicating and learning through the inclusion of Cultural/Indigenous Knowledge (IK). The inclusion of IK provides a mechanism and potential action for change for both Native and non-Native students to understand the critical role cultural knowledge has within the learning environment. Developing "best management practices (BMP's) will be one of the final products of this research to assist in the knowledge transfer beyond Maine.

Preliminary results from a pilot study in Spring 2018, showed over 80% of the students in the forestry classes had a strong desire to have IK and western science included in future curriculum. The WaYS educational model is proving to be an effective mechanism to create change not only for Native students to learn about science but non-Native students. This educational model can help address sustainability challenges for all learners.

8:45 – 9:00AM

Brieanne Berry (student)[1], **Shayla Rose Kleisinger** (student)[2], **Taylor Patterson** (student)[2]
1 Department of Anthropology, University of Maine, Orono, ME; brieanne.berry@maine.edu
2 University of Maine, Orono, ME

Co-Learning Sustainability Science & Policy: An Interdisciplinary Approach to Food Waste Reduction

Food waste is a complex issue that is situated at the intersection of multiple academic disciplines. For several years the Materials Management Research Group, an interdisciplinary team based out of the University of Maine's Senator George J. Mitchell Center for Sustainability Solutions, has sought to connect research to practice on food waste issues in Maine. With a goal of increasing student engagement at all levels, and with support from multiple funders, in 2018 the Research Group established a program to train a team of undergraduates in interdisciplinary research centered around issues of food waste. This team of five students represents a broad range of academic

disciplines, with the goal of conducting research to build a more circular food system in Maine. We present a case study of our first team of scholars, sharing some of the obstacles we faced in training students in interdisciplinary, solutions-oriented research. We also share the impact this program has had on our students, along with implications for other contexts and opportunities for collaboration across the state of Maine. We found that although interdisciplinary work is complex and often slow-moving, it presents important opportunities for undergraduate and graduate student collaboration, as well as contributions to real-world problem solving.

9:00 – 9:15AM

Donelle Schwalm
Department of Biology, University of Maine at Farmington, Farmington, ME; donelle.schwalm@maine.edu

Conservation in the National Parks: Past, Present and Future

With the dual mandates of preservation and accessibility, the National Parks are one of the United States' best-known and most visible experiments in sustainability. I will present the framework for an in-development course that offers an in-situ, experiential learning opportunity for undergraduate students. Students will travel from the University of Maine-Farmington to the western United States, where they will spend 2.5 weeks completing a driving circuit, visiting approximately seven National Parks in eight states. Parks were chosen based on their potential to showcase at least one of the following: ecological diversity conserved in the National Parks System (NPS), history of the NPS, cultural value and indigenous history, conservation action within or in collaboration with the NPS, and emergent challenges associated with climate change, development outside park borders, and/or increasing visitor pressure. I will discuss the intended learning outcomes and the approaches used to engage students in both faculty-directed and self-directed learning. Insights into logistics, budgeting, timing and safety management will also be provided. Finally, I will discuss possible ways that this course could be modified to incorporate other forms of land preservation and ecological conservation (federal, state, NGO and private), with a focus on the eastern U.S.

9:15 – 9:30AM

Douglas Reusch[1], Peter Hardy[1], Kristen Case[1], Lucas Kellett[1], Paul Stancioff[1], Andrew Barton[1], Rachel Hovel[1], Matthew McCourt[1], Jesse Minor[1], Wendy Harper[1], Linda Beck[1], Maurice Martin[1], John Messier[1], Natasha Lekes[1], Katrazyna Randall[1], Patti Bailie[1], Karl Kreutz[2], Kirk Maasch[2]
1 University of Maine at Farmington, Farmington, ME; reusch@maine.edu
2 University of Maine, Orono, ME

Sink or Swim: A Foundation Course in Sustainability for All by All

The world's responsible governments, prodded by sound science, have challenged us to halve emissions by 2030. Meanwhile, the inverse relationship between biodiversity and humanity's success (7.7 billion in number, collectively converting energy at >18 TW) further fuels the need to veer off a business-as-usual trajectory. How can universities, ripe with faculty expertise and student energy, contribute? What if the vast majority of early college students, about to make critical life choices, were to acquire both a deep understanding of the problem and the resolve to enact solutions?

At the University of Maine at Farmington (UMF), a group of faculty from all corners of campus is piloting an interdisciplinary course "Building a Sustainable Future." The semester will open and close with perspectives from the humanities. Essential background material from earth system science will set the stage for a diverse landscape of

constructive responses, i.e., the various levers with potential to change humanity's trajectory. Here, the social sciences play a large role in figuring out how the economic, political, social, and psychological pieces of the puzzle fall into place.

Special weekly presentations by disciplinary experts constitute the skeleton of the semester, to be complemented by student engagement in the analysis of close-to-home case studies (e.g., nearby renewable energy projects, critical minerals, local agriculture). Experiments with various pedagogical techniques (e.g., dynamical systems modeling, games/simulations, local field trips) will be assessed through the semester. The ultimate vision is a template that works when scaled up and exported to nourish a widespread culture of sustainability and earth stewardship.

9:30 – 9:45AM

Julia Daly
Dept. of Geology, University of Maine at Farmington, Farmington, ME; dalyj@maine.edu

Mining in Maine? A Focus Topic for an Introductory Environmental Geology Course

One of the key questions about green/sustainable energy expansion is the production of raw materials to support this effort. In addition, recent changes in Maine's mining regulations highlighted mineral reserves in the state and the potential for their removal. This prompted me to design an introductory-level Environmental Geology course with an emphasis on this question: should mining be expanded in Maine? The course culminates with an in-class debate during the final week of the semester, but the topic provides a common thread to a variety of class and lab activities throughout the semester. Mineral characteristics and identification, basic rock identification, geologic map reading, watersheds and surface hydrology, and Maine's plate tectonic history can all be tied to this question. We visit a local active granite quarry and learn about their methods for extraction and waste management, prompting the students to realize that the term "mining" is very broad and that removal of different materials carries different environmental concerns. As we move closer to the end of the semester, I assign students to teams based on a pre-assessment that included a simple gauge of their support for mining in Maine near the beginning of the semester. The teams are a mix of students who self-identified as either pro or con; each team is responsible for deciding on major topics, researching fact sheets, and developing debate questions. Following the debate, students have the opportunity to reflect on the question and how understanding geology can help inform their position.

9:45 – 10:00AM

Peter Hardy
Mathematics, University of Maine at Farmington, Farmington, ME; peter.hardy@maine.edu

Post-Apocalyptic Survivor: A Game to Examine the Consequences of Environmental Collapse

It is February of 2019. Two weeks ago a coordinated series of eco-warrior attacks have severely damaged the extraction, refinement and distribution of oil worldwide causing widespread chaos and mayhem. The United States has declared a state of emergency for the entire country. Gasoline is being rationed. A blackout of the entire region began three days ago with no timetable for the restoration of electric service.The university has closed its doors and told all of its students to go home, but all of the gasoline in your car has been siphoned and there is nowhere you can buy more. Having run out of options, you decide to hole-up at your forward-thinking professor's farm with the rest of your classmates. Your task is to survive the winter and make plans to survive long-term if humanity never recovers from this calamity.

Session 7: Developing Effective Sustainability Curricula

The above scenario has been presented to students of sustainability as a semester long project/game in which they must cooperate with and compete against each other and various other factions for dwindling resources in a world-wide crisis. The game helps them to begin to think about what life might be like in a post-fossil fuel world if viable energy alternatives are not implemented before fossil fuels run out. It is a somewhat light-hearted way for students to examine the consequences should we not find solutions to the myriad challenges facing humanity in the twenty-first century. The game could be modified for a wide range of courses which touch upon sustainability.

10:00 – 10:15AM

Jesse Minor[1], Neil Prendergast[2]
1 Dept. of Geography & Environmental Planning, University of Maine at Farmington, Farmington, ME; jesse.minor@maine.edu
2 Department of History and International Studies, University of Wisconsin Stevens Point, Stevens Point, WI

Teaching Sustainability by Linking Environmental History and Political Ecology for Effective Field-Based Pedagogy

Scholars and educators who teach sustainability topics using field-based, experiential pedagogy can gain powerful tools for understanding environmental change by combining techniques from the fields of environmental history and political ecology. In field settings, we frequently encounter landscapes in which facets of the important story are no longer visible, having been overwritten by more recent geomorphic, biological, and anthropogenic forces and processes. Environmental history and political ecology both provide useful intellectual structure for addressing sustainability topics, particularly those in which the influence of the past has a high degree of influence on contemporary and future conditions. Environmental history, with its focus on human interactions with the natural world over time, delivers a deeper historical perspective and context than is often evident at the veneer of the site level. Political ecology, which understands environmental change as a combination of biophysical and political, economic, and social factors, offers tools and techniques for interrogating recent changes to landscapes. By combining the intellectual frameworks of political ecology and environmental history, sustainability educators can more effectively interrogate and explain environmental change. These complimentary approaches to understanding environmental change can be combined with additional sustainability-related disciplines to yield novel interdisciplinary insights and more effective field-based teaching. In this presentation, we illustrate the potent insights that can be gained by combining environmental history and political ecology using examples from a field-based course focusing on a suite of cultural, economic, and ecological changes on the Santa Cruz River and in Tucson, Arizona.

10:15 – 10:30AM

Susan G. Letcher
College of the Atlantic, Bar Harbor, ME; sletcher@coa.edu

Restoration Ecology as a Framework for Teaching Sustainability

My primary goal as a professor is to equip students with skills and habits of mind that will enable them to confront an uncertain future and find solutions instead of becoming mired in problems. In a decade of undergraduate teaching, I have found that the course that is most effective in engaging undergraduates and transforming their views about sustainability is an intermediate-level course on Restoration Ecology. This emerging field of biology

focuses on using science to guide the renewal of ecological systems damaged by human activity. As an inherently transdisciplinary field, Restoration Ecology forces its practitioners to move outside their comfort zones, engaging with diverse stakeholders and grappling with problems that span the biological, social, and political realms. It calls us to critically examine the ethics of the human relationship with the Earth and its ecological systems. And as a field focused on active solutions, it provides an antidote to the despair that often undermines real progress toward sustainability. Teaching Restoration Ecology as a project-based course with real-world applications makes it particularly compelling. In this talk, I will address the features of the class that make it effective, and I will advocate for greater diffusion of the key concepts of Restoration Ecology at the undergraduate level.

Section B - Sustainability Curricula

1:30 – 1:45PM

Susan E. Farady
University of New England School of Marine Programs, Biddeford, ME; sfarady@une.edu

Reinventing an Interdisciplinary Marine Affairs Curriculum for the 21st Century

In 2013, the University of New England developed a new interdisciplinary major in marine affairs to meet the needs of students interested in the ocean who do not want to pursue a marine science degree or science career path. The marine affairs curriculum was assessed against similar curricula in 2014-16 to ensure the curriculum was competitive with other schools, could be delivered with current resources, and provided students the skills needed to pursue career paths in marine-related policy, outreach and education, and management. The review revealed that marine affairs students did not need the full suite of biology, math and chemistry courses typically required for marine science degrees. It was also determined that students needed exposure to GIS, environmental economics, and law and policy in order to be fluent in interdisciplinary marine management and conservation issues. Finally, students need exposure to different disciplines and organizations engaged in marine management, as well as hands-on opportunities; to accomplish this, students must take at least one course in outreach/education, one course in business organization and management, do at least one 3-credit internship, and complete a senior marine affairs capstone project. Many of these changes required cooperation among different departments and institutional flexibility to offer the range of courses required. The revised curriculum has improved student retention, exposes them to many career path options, and provides them with essential interdisciplinary skills to address sustainable marine resource management in the 21st century.

1:45 – 2:00PM

Lucas C. Kellett[1], Drew Barton[2]
1 Anthropology and Archaeology, Sustainability Coordinator, University of Maine at Farmington, Farmington, ME; luke.kellett@maine.edu
2 Biology, University of Maine at Farmington, Farmington, ME

University Sustainability as a Teaching Tool: Applications from the University of Maine at Farmington

This presentation highlights the role that university sustainability work can play in supporting sustainability education and awareness. Using examples from the University of Maine at Farmington (UMF), the authors discuss how university infrastructure (e.g., renewable energy) and sustainability initiatives (e.g., compost, food pantry) has supported sustainability coursework and student research in a myriad of ways. UMF's Sustainable Campus Coalition

(SCC) in particular, has served as an important interdisciplinary campus-community based organization to support sustainability curricula and research. In addition, the SCC has provided an important space in which students and others can discuss and engage in local, regional and global environmental and sustainability issues. Finally, the authors emphasize how UMF continues to serve as a real world "sustainability laboratory" to understand and teach the complex process of sustainability-based decision making.

2:00 – 2:15PM

Lora Winslow[1], **Ethel Wilkerson**[1], **Abigayl Novak** (student)[2]
1 Sustainable Economies, Manomet, Brunswick ME; lwinslow@manomet.org; ewilkerson@manomet.org
2 University of Maine, Orono ME; abigayl.novak@maine.edu

Preparing the Next Generation: A Sustainability Curriculum Focused on Professional Development

U360 is a curriculum-based sustainability internship program for college undergraduates. U360 gives environmental, business, economics, and science students real-world experience in three vital areas that are not taught in the classroom: applied sustainability, career skills, and how to engage people with differing viewpoints. While academic, technical, and scientific knowledge about sustainability is extremely important, that alone will not fully prepare students to tackle the complex environmental, social, and economic challenges facing their generation after graduation. Academic coursework must ideally be coupled with experience in the practical application of sustainability principles. College students need to know how to work with people who think differently from them, understand that solutions must be based on reality rather than theory, possess the interpersonal skills needed to engage others in problem-solving, and be ready to enter the workforce. Since its launch three years ago, over 70 students from ten universities (including six in Maine) have participated in the U360 curriculum, which includes sustainability workshops; career skills trainings; interviewing small businesses and administering Manomet's sustainability assessment; creating a sustainability action plan; and presenting the action plan at a competition. While the educational focus of U360 is small business sustainability, the knowledge and professional skills gained can be applied to any job or industry. Most importantly, the understanding of how to develop practical, creative solutions can be applied to any area of sustainability. Our presentation will include detailed information about the U360 curriculum, evaluation metrics, and a first-hand account from a U360 "alum" from University of Maine.

2:15 – 2:30PM

Shawn Mercer, Maizey Mercer (student)
Rural Roots Revival; shawn@greatpondtrust.org

Guiding Learners Towards Authentic Leadership and Purpose

This presentation uses spoken word, images, and original acoustic music to break through resistance, doubt, and other thoughts of ineffectiveness and invites attendees to explore aspects of authentic leadership as pathways to a heart-centered place of action and purpose for both instructors and students. With the uncertain future that today's youth are facing, they desire opportunities to contribute to work that has purpose and meaning; that contributes to solutions for a sustainable future. This presentation will discuss ways we can guide them in developing resilience, motivation, dedication, and a strong sense of purpose and efficacy. Our hope is that students and teachers will leave with the skills, knowledge, and enthusiasm needed to integrate this deeper level of learning into the regular curriculum.

Session 7: Developing Effective Sustainability Curricula

2:30 – 3:00PM

Break – Auditorium

Section C - Business

3:00 – 3:15PM

John Rooks
THE SOAP Group; jrooks@thesoapgroup.com

Teaching the Building of a Culture of Sustainability

Our solutions to the problems of climate change are 50% technical and 100% cultural. Teaching the strategies of building a culture (civic, corporate) of sustainability is an under-valued strategy for future sustainability practitioners.

The purpose of this presentation is to offer timely insights into corporate culture management when it comes to sustainability and to introduce a modern audit protocol to measure the authenticity of sustainability actions, commitments and messaging.

This presentation is three-fold:

Presentation of first-hand case studies from corporations who have built authentic sustainability cultures (Interface Carpet, VANS).

Introduction of an audit protocol used to test the authenticity of an organization's commitment to sustainability.

Facilitate a broad discuss the role culture plays in sustainability.

Participants will take away concrete examples of authentic corporate cultures focused on sustainability (and how they achieved them), a protocol to test in field studies outside the classroom, and a broader understanding of the role that culture must play in addressing climate change.

3:15 – 3:30PM

Peter Cooke[1], Mike Dart (student)[2]
1 Manomet, Brunswick, ME; pcooke@manomet.org
2 University of Southern Maine, Portland, ME

Students Providing Sustainability Assessments for Sector Based Businesses

Adjunct Professor Peter Cooke has been taking students out of the classroom and bringing them on-site to actual businesses to provide sustainability assessments. Mr. Cooke's on site experiences for his classes have focused on businesses that have a role in the tourism economy in Maine (hotels, restaurants, brew pubs, and grocery stores). These are businesses that people already have an intimate familiarity with but in this class, students begin to see the businesses though a new perspective of sustainable performance. Students are taught how to provide effective sustainability assessments covering the flow of energy and materials through these businesses. They are also taught how to effectively facilitate an effective on-site visit. Identifying opportunities at businesses is always educational, but how does one get the businesses to then perform better and take action on potential cost saving recommendations. The curriculum for the sustainability courses taught by Mr. Cooke includes these concepts and tools that be-

Session 7: Developing Effective Sustainability Curricula

come skills as the semester advances. Criteria from state sustainability programs are also built into the curriculum. Colleges in New Mexico, New Jersey, and New Hampshire are all working with Mr. Cooke to replicate the methodology.

3:30 – 4:00PM

Discussion

Co-chairs Rachel Hovel and Denise Bruesewitz will lead a discussion to summarize session content, address questions from the audience, and discuss next steps for implementing sustainability curricula.

Session 8 (All-Day Session)

Providing Science-Based Decision Support for Sustainability

Effective delivery of science-based information is essential for any public- or private-sector decision-making process intended to advance sustainability. Regardless of the issue at hand, decision-makers and stakeholders need salient, credible, and legitimate science that enables them to make well-informed decisions that will lead to effective actions to increase sustainability. Often the necessary scientific knowledge either does not exist yet or is not available in a form that is readily accessible and usable by the people involved in decision-making. Many organizations face the challenge of addressing this gap through knowledge co-production, development of new decision-support tools, and other approaches. The common thread is the need to deliver science-based information to people who are not scientific experts but want and need the information to make decisions. In many cases, these efforts engage multiple fields of expertise and involve production of "boundary objects" such as interactive maps, user-friendly websites, and non-technical publications. This session will focus on interdisciplinary efforts to develop processes and tools that bring together science, policy, management, and stakeholders for better decision making.

** 4.5 credits are available for this session through APA AICP*
** One presentation in this session has been approved for training contact hours (TCH) through the State of Maine Board of Licensure of Water System Operators. Please see below for details.*

Session Overview

8:30AM – 8:55AM Susie Arnold, Jeremy Bell
A Map, a Stick and a Cartoon: Alternative Approaches to Information Sharing Around the Causes and Impacts of Sea Level Rise

9:00AM – 9:25AM Melissa. E. Flye (student)
Communication and Collaboration within the Atlantic Salmon Governance Structure of Maine

9:30AM – 9:55AM Erik Martin, Benjamin Matthews
Methods for Aquatic Connectivity Barrier Prioritization: A Decision Support Tool for the Penobscot Watershed in Maine

10:00AM – 10:25AM Sam Merrill, Martha Sheils
Capital Plans, Meet Comprehensive Plans: Municipal Use of a DOT Tool for Risk-Based Asset Management

Session 8: Decision Support for Sustainability

1:30PM – 1:55PM Mackenzie Mazur (student)
Developing a Management Strategy Evaluation Framework for the Gulf of Maine American Lobster Fishery

2:00PM – 2:25PM Sarah Vogel (student)
What Does "Best Available Science" Mean in the FERC Hydropower Relicensing Process?

2:30PM – 3:00PM Break (Auditorium)

3:00PM – 3:25PM Gabriella Marafino (student)
Making Science Useful to Decision-Makers in the Context of Tidal Power Development

3:30PM – 3:55PM Tora Johnson, Andrew Howland (student). (0.5 TCH)
How Much Risk Is too Much? Geographic and Economic Analysis to Support Local Decisions About Flood Resilience in a Downeast Community

Session Co-Chairs

Peter H. Taylor
Waterview Consulting

Bridie McGreavy
Dept. of Communication & Journalism, University of Maine, Orono, ME; bridie.mcgreavy@maine.edu

For more than two decades, **Peter Taylor** has developed communication strategies and created communication products for nonprofit, government, commercial, and academic entities at local to international scales. After earning a B.A. in biology from Williams College and a master's in ecology from the University of California Santa Barbara, he worked as a magazine editor, web designer, and freelance writer/photographer. In 2003, he founded Waterview Consulting to help clients translate data, information, and ideas into knowledge, decisions, and actions. Waterview Consulting often provides support for interdisciplinary, multi-stakeholder initiatives, bringing an objective, creative, audience-focused perspective. Recent projects include website design and production (NortheastOceanData.org; CatchShareIndicators.org; California Fisheries Portal Prototype), conceptual planning for a decision support tool (UMaine), writing/design of habitat restoration publications (The Nature Conservancy of Washington; Penobscot River Restoration Trust), and writing/editing of estuarine management plans and status reports (Narragansett Bay Estuary Program; Peconic Estuary Program). Waterview Consulting is located in Harpswell, Maine, and works with clients throughout the U.S. and abroad..

Bridie McGreavy is an assistant professor of environmental communication in the Department of Communication and Journalism and a faculty fellow in the Senator George J. Mitchell Center for Sustainability Solutions at the University of Maine. Her environmental communication research focuses on how communication shapes sustainability and natural resource management efforts. She has been working with the shellfish industry and coastal communities since 2012 and is currently a member of the Maine Shellfish Advisory Council. She received a Ph.D. in communication and sustainability science from the University of Maine.

Session 8: Decision Support for Sustainability

8:30 – 8:55AM

Susie Arnold[1], Sam Belknap[1], **Jeremy Bell**[2], Teresa Crean[3], Liz Hertz[4], Eileen Johnson[5]
1 Island Institute, Rockland, ME; sarnold@islandinstitute.org
2 The Nature Conservancy, Brunswick, ME; jbell@tnc.org
3 University of Rhode Island Coastal Resources Center, Narragansett, RI
4 Blue Sky Planning Solutions, Augusta, ME
5 Bowdoin College, Brunswick, ME

A Map, a Stick and a Cartoon: Alternative Approaches to Information Sharing Around the Causes and Impacts of Sea Level Rise

The impacts of sea level rise (SLR) and coastal flooding are clear threats to coastal communities. However, the complex geophysical processes behind these impacts are often not well understood by the general population. Translating scientific information on a variety of climate change impacts to the non-scientific community has been the focus of increased research over recent years. Our presentation describes three approaches developed by the Island Institute, The Nature Conservancy, and the University of Rhode Island Coastal Resources Center that, while utilizing different strategies, all aim to translate complex scientific information into a form more easily digestible by the public. We examine the use of animation, interactive map viewers, and visual storytelling to highlight a few of the ways that boundary organizations can help motivate conversations and adaptive actions within communities wrestling with the challenges of sea level rise and other climate impacts. The presentation will kick-off with the Island Institute's screening of the most recent O'Chang Studios cartoon that highlights the causes and impacts of SLR in Maine. O'Chang Studios animations have proven successful in raising awareness around other climate change related issues including ocean warming, ocean acidification, and invasive species. The Nature Conservancy will share their Coastal Risk Explorer tool that allows users to identify inundated roads, locations that are cut off from emergency services, approximate costs to upgrade the roads, as well as the social vulnerability of affected communities. Finally, we will share the story of the acclaimed Rhode Island Sea Level stick through photos and a do-it-yourself tutorial.

9:00 – 9:25AM

Melissa. E. Flye (student)[1], Carly. C Sponarski[2], Joseph. D. Zydlewski[2,3], Bridie McGreavy[4]
1 University of Maine, Ecology and Environmental Science, Orono, ME; melissa.flye@maine.edu
2 University of Maine, Department of Wildlife, Fisheries, and Conservation Biology, Orono ME
3 U.S. Geological Survey, Maine Cooperative Fish and Wildlife Research Unit, Orono, ME
4 University of Maine Department of Communication and Journalism, Orono, ME

Communication and Collaboration Within the Atlantic Salmon Governance Structure of Maine

The Atlantic salmon population in Maine remains critically low despite extensive hatchery supplementation and habitat improvement efforts. In 2000 the Gulf of Maine Distinct Population Segment was listed as an endangered species with joint listing authority shared by the National Oceanic and Atmospheric Administration and the United States Fish and Wildlife Service. Because, regulators and managers from Federal, State, and Penobscot Nation contexts operate with independent authority, recovery decisions depend upon effective communication and coordination. Using a mixed-methods approach we surveyed and interviewed members of the Atlantic Salmon Recovery Framework (ASRF), the governance structure responsible for Atlantic salmon management and recovery in

Session 8: Decision Support for Sustainability

Maine. The communication network analysis utilized survey results to better understand the flow of information and communication between members of ASRF and found that there is a relatively high network density for individual communication, but that these communications are poorly centralized and may be more compatible with some organizational structures than others. Communicative relationships formed distinct communities falling generally along organizational boundaries, indicating that individual communicative relationships are reflective of organizational affiliation rather than framework structure. Challenges reported by members fit generally into three categories, membership confusion, mismatches between framework and organizational structures, and poorly defined responsibilities. Despite these challenges, participants reported a commitment to maintaining a collaborative governance structure. Individuals reported long-standing relationships and a history of working together within and between organizations. This coupled with a high network density, show that communication pathways exist and may be built upon moving forward.

9:30 – 9:55AM

Erik Martin, Benjamin Matthews
The Nature Conservancy, Brunswick, Maine; emartin@tnc.org; benjamin.matthews@tnc.org

Methods for Aquatic Connectivity Barrier Prioritization: A Decision Support Tool for the Penobscot Watershed in Maine

The Nature Conservancy's efforts to assess barriers to the Aquatic Connectivity of Maine's rivers and streams over the past 10 years has resulted in a comprehensive dataset of more than 20,000 road/stream crossings and dams across the State. Removing and/or replacing problem road/stream crossings provides the best leverage to creating healthy, abundant sportfish and forage fish populations that can survive extreme floods, drought events, and fishing pressure. To assisting stakeholders to allocate limited resources to the most beneficial barrier removals, we have developed a dynamic tool for multiple users to assess the most valuable barrier removal project. Our decision support tool provides a heads-up prioritization scalable based on geographic extent, as well as providing a back end customizable analysis for diverse stakeholders that want to create tailored results based on specific restoration objectives. This presentation will walk through the enabling conditions that allowed us to create this tool, review the prioritization methods & metrics and showcase the results in the live version of the tool.

10:00 – 10:25AM

Sam Merrill[1], **Martha Sheils**[2]
1 GEI Consultants, Portland, Maine; smerrill@geiconsultants.com
2 New England Environmental Finance Center, University of Southern Maine, Portland; martha.sheils@maine.edu

Capital Plans, Meet Comprehensive Plans: Municipal Use of a New DOT Tool for Risk-Based Asset Management

The Maine Department of Transportation (Maine DOT) developed a screening tool to meet their federal mandate to establish a process for risk-based transportation asset management planning. The "Transportation Risk Assessment for Project Planning and Delivery" (TRAPPD) initiative considers risk in terms of project delivery (i.e., on schedule, on budget) for infrastructure replacements and upgrades of state owned culverts and bridges. TRAPPD provides a numeric comparison using existing data that asset managers can view online and adjust expectations for

asset condition and project delivery in real time. This capability represents a transition from proof-of-concept status to an automated, implemented, and transferable framework for risk-based decision-making by Maine DOT.

But can the TRAPPD tool also be used to inform municipal level planning and decision-making about which culverts and bridges to replace, and when? To find out, the New England Environmental Finance Center conducted a pilot study in the Town of Scarborough, Maine to test the tool's applicability to inform local asset replacement as laid out in the town's comprehensive and capital improvement plans. This presentation will describe the Maine DOT tool and the results of the pilot project. The discussion will explore the future vision of how other Maine municipalities may benefit from using the tool, and the process to fit municipal data into the state DOT framework.

1:30 – 1:55AM

Mackenzie Mazur (student), Teresa Johnson
School of Marine Sciences, University of Maine, Orono, ME; mackenzie.mazur@maine.edu

Developing a Management Strategy Evaluation Framework for the Gulf of Maine American Lobster Fishery

Management strategy evaluation (MSE) is an emerging approach used to inform decision-making in fisheries management. MSE includes choosing management objectives, identifying measures of performance, identifying alternative management strategies, and using simulations to evaluate these management strategies. However, MSE has not yet been developed for the valuable and rapidly changing Gulf of Maine (GOM) American lobster fishery. The goal of this research is to integrate quantitative fisheries modeling and social science to develop an MSE framework that will be used for evaluating alternative management strategies in a changing GOM and to provide critical management advice for the development of a resilient fishery. The American lobster population and fishery are changing rapidly, and it is unclear what will happen to the population and fishery in the future. Social science can provide new insight into the uncertainties of the fishery and population and goals of the lobstermen by integrating harvester knowledge into decision-making. In this study, we used semi-structured interviews, oral history interviews, and surveys to identify lobster harvesters' management objectives and uncertainties and incorporated these into an individual-based lobster simulator. The simulator is then used to evaluate different management strategies. In this study, landings, biomass, and recruits from the different management strategies are compared to the management objectives identified by lobster harvesters. This study will provide a platform to answer "what-if" questions in the Maine lobster fishery management and inform the lobster industry and management agencies of possible consequences of changes in management strategies in a changing GOM.

2:00 – 2:25PM

Sarah Vogel (student)[1], Jessica Jansujwicz[1,2], Joseph Zydlewski[1,3]
1 Department of Wildlife, Fisheries and Conservation Biology, UMaine, Orono, Maine; sarah.vogel@maine.edu
2 Senator George J. Mitchell Center for Sustainability Solutions, UMaine, Orono, ME
3 U.S. Geological Survey, Maine Cooperative Fish and Wildlife Research Unit, Orono, ME

What Does "Best Available Science" Mean in the FERC Hydropower Relicensing Process?

Over the next decade, 25% of active hydropower projects nationwide will require relicensing by the Federal Energy Regulatory Commission (FERC). Making informed decisions about hydropower operations and management during relicensing requires the production and use of science. Under existing law, agency regulators must use the best

available science to make decisions that may affect local communities and ecosystems. Although embraced as the standard, this term is not well-defined. We sought to (1) enhance our understanding of how agency stakeholders define "best available science," (2) identify the informational sources used in relicensing decisions, and (3) assess agency perceptions of the information and how it is used in relicensing decisions. We used dams located in the Kennebec and Penobscot River Watersheds in Maine as our study region. Official relicensing documents were collected (n=100), organized, and citations analyzed. The results demonstrate that FERC and licensee documents were largely comparable in citation composition, averaging 50 citations per document and employing 20% federal and 20% licensee informational sources. FERC and licensees cited peer-reviewed literature less than 20% of the time compared to 50% citation by federal agencies. An online questionnaire was implemented to further explore patterns of agency decision-making. Preliminary findings (n=55) indicate that federal agency stakeholders use peer-reviewed literature more frequently than state agencies. Further analysis will examine agency perceptions of information sources. An enhanced understanding of how agencies utilize, and value scientific information may help identify pathways for timely and better-informed relicensing decisions.

2:30 – 3:00PM

Break – Auditorium

3:00 – 3:25PM

Gabriella Marafino (student)[1], Jessica Jansujwicz[2], Gayle Zydlewski[1,3], Teresa Johnson[1]
1 School of Marine Sciences, University of Maine, Orono, ME; gabriella.marafino@maine.edu
2 Department of Wildlife, Fisheries, and Conservation Biology, University of Maine, Orono, ME
3 Maine Sea Grant College, University of Maine, Orono, ME

Making Science Useful to Decision-Makers in the Context of Tidal Power Development

A major barrier to bridging the gap between scientific knowledge and decision-making is the lack of "usable" information. Data are often not presented in a form that fits the specific needs of diverse stakeholders, and it is challenging to integrate data from disparate sources and scales. In response, this research focuses on knowledge co-production and sharing to support decision-making for sustainable tidal power development in eastern Maine. A series of four stakeholder workshops are being organized to discuss existing information, knowledge gaps, and data integration strategies to generate a more complete understanding of the ecosystem at the proposed tidal power site. Key stakeholders are being engaged to tailor data integration and sharing in a way that fits the needs and capacities of decision-makers. The groups engaged in these workshops include state and federal regulators, the industry developer, and a tribal environmental department. Stakeholders involved in the first workshop identified that it would be useful to have a central repository for the ecosystem information, as well as to have the data represented spatially to serve as a decision-support tool. Subsequent workshops and interviews will be used to monitor how responsive the decision-support tool is to stakeholder concerns. Although marine renewable energy is relatively new, it is becoming increasingly important as an alternative to traditional fossil fuels. Applications of this case study could help improve decision-making in other locations seeking information about the feasibility of developing marine renewable energy.

Session 8: Decision Support for Sustainability

3:30 – 3:55PM

Tora Johnson, **Andrew Howland** (student), David Cisneros
University of Maine at Machias, Machias, Maine; tjohnson@maine.edu; andrew.howland@maine.edu

How Much Risk Is too Much? Geographic and Economic Analysis to Support Local Decisions About Flood Resilience in a Downeast Community

After studies showed significant, increasing flood risk to downtown Machias, the coastal Downeast town formed a committee to develop a plan to protect the commercial district and wastewater treatment facility. The committee's work on flood barrier options was complicated by uncertainties about risk, limited data, and resistance to change among stakeholders. University of Maine at Machias faculty and students collaborated with the Machias Downtown Resilience Committee, the Washington County Council of Governments, and an engineering firm to provide decision support. To help the group weigh costs of alternative designs against risks, we gathered best available data on flood impacts and applied best practices for mapping and science communication to estimate potential impacts for a variety of flood scenarios. The approach involved co-production of knowledge, focus on local priorities and vulnerabilities, and scaling maps and economic information to local needs. We found inundation at the base flood elevation (BFE = 10.7 feet) could cause $700,000 in damage and take two months for recovery with relatively minor ecosystem impacts. The town had experienced two floods near BFE in recent years. With floods two or more feet above BFE–increasingly likely due to climate change–potential impacts rise dramatically: BFE plus two feet could cost $8 million with six months' recovery. BFE plus 4 feet could cost $17 million with 11 months' recovery and major impacts on shellfisheries. The community is now pursuing funds to engineer flood protection scaled to protect the town against a BFE plus four feet scenario.

Session 9 (All-Day Session)

Migratory Fish Passage

This session will explore the ecological conduit coastal rivers create for migratory fish moving between fresh and seawater ecosystems. Presentations on fish passage, habitat fragmentation, ecological service of migrations and life history dynamics are included.

** 4.5 credits are available for this session through APA AICP*

Session Overview

8:30AM – 8:55AM Michael Burke, Maranda Nemeth
Dam Removal as a Collaborative, Multi-Objective Solution to Fish Passage and Fire Protection Deficiencies at Coopers Mills, Sheepscot River

9:00AM – 9:25AM David Cloutier
Exeter Dam Removal: A Blueprint for Successful Fish Passage Restoration on the Exeter River

9:30AM – 10:00AM Two 15-minute presentations
A. Alejandro Molina-Moctezuma (student)
Historical Movement and Survival of Atlantic Salmon Smolts in the Piscataquis River from 2009-2018
B. Matthew Mensinger (student)
American Eels Incur High Mortality at Dams During Seaward Migration in the Penobscot River

10:00AM – 10:30AM Two 15-minute presentations
A. Michael Chelminski
Revisiting the Blackman Stream Fishway at Leonard's Mills
B. Erin Peterson (student)
American Shad Demography and Motivation: A Re-evaluation of Penobscot River American Shad Post Dam Removal

1:30PM – 1:55PM Jacob T. Aman
Developing Cost Effective Monitoring for Rainbow Smelt Using eDNA

2:00PM – 2:25PM Katherine A. Littrell (student)
River Restoration Project Mediates Secondary Contact between Anadromous and Landlocked Alewife

Session 9: Migratory Fish Passage

2:30PM – 3:00PM Break (Auditorium)

3:00PM – 3:25PM Two 15-minute presentations
A. Sarah Rubenstein (student)
Energetic Impacts of Passage Delays in Migrating Adult Atlantic Salmon
B. Molly Payne Wynne, Alicia Heyburn
A Year and a Day for Salmon: Local to Global Outreach Events Raising Awareness for Migratory Fish

3:30PM – 4:00PM Two 15-minute presensations
A. Elizabeth Bishop-Hyslop
River Herring Population in the St. Croix River: Fish Counts at Milltown Dam
B. Daniel Weaver
Where There's a Will, But Not a Way: Behavior of American Shad Approaching the Brunswick Dam Fishway on the Androscoggin River, Maine

Session Chair

Joe Zydlewski
Wildlife, Fisheries & Conservation Biology, UMaine; USGS Maine Cooperative Fish and Wildlife Research Unit; josephz@maine.edu

Joe Zydlewski is Assistant Unit Leader in the USGS Maine Cooperative Fish and Wildlife Research Unit and professor of fisheries science in the Department of Wildlife, Fisheries, and Conservation Biology at the University of Maine. Joe earned a B.S. in Chemistry and Biology from Bates College in Maine and a Ph.D. in Biology from the University of Massachusetts, Amherst. Joe's work centers on the movements and migrations of fish regarding physiology, behavior and river restoration.

8:30 – 8:55AM

Michael Burke[1], Andrew Goode[2], Maranda Nemeth[3], and Matt Bernier[4]
1 Inter-Fluve, Inc, Damariscotta, ME; mburke@interfluve.com
2 Atlantic Salmon Federation, Brunswick, ME
3 Midcoast Conservancy, Edgecomb, ME
4 NOAA Restoration Center, Orono, ME

Dam Removal as a Collaborative, Multi-Objective Solution to Fish Passage and Fire Protection Deficiencies at Coopers Mills, Sheepscot River

Initially developed to power local mills in the early 1800s, the primary function of the Coopers Mills dam for the last several decades was to provide a reliable pool for fire protection water supply. Fish passage facilities had been constructed at the site in the 1950s in the form of a standard 3-foot wide Denil fishway. Deferred maintenance of the dam structure led to extended periods where both the fire protection water supply and fish passage functions were adversely impacted. A collaborative project was developed by the Town of Whitefield, the Atlantic Salmon Federation, and their partners to resolve these issues, and also enhance the site. Completed in Fall 2018, the Coopers Mills Dam Removal and Site Enhancement removed the dam to restore native fish passage potential, replaced the fire protection water supply system with an enhanced, redundant system, and created public use and educational features to broaden the acknowledgment of the historical role of the site in the village of Coopers Mills. The

implemented project is the culmination of two decades of evaluation, discussion and planning by a variety of engaged groups. The presentation will provide an overview of the final project, and explore the relationship of this site to the broader multi-site restoration initiative within the Sheepscot watershed by ASF and their partners.

9:00 – 9:25AM

David Cloutier, Jake San Antonio
VHB, South Portland, ME; dcloutier@vhb.com

Exeter Dam Removal: A Blueprint for Successful Fish Passage Restoration on the Exeter River

Located at the edge of the Squamscott River tidal estuary in historic downtown Exeter, New Hampshire, the Great Dam was a 136-feet-long by 16-feet-high reinforced concrete run-of-river dam. A fish ladder, installed in the 1960s to help restore passage for diadromous fish, proved inefficient at allowing upstream travel; the dam also represented a safety and flood hazard liability. Recognizing the ecological value of dam removal, the Town of Exeter enlisted VHB to develop channel fish passage design, secure grant funding and permits, and implement a comprehensive post-construction monitoring plan. The purpose of these actions was to create a framework to restore and maintain fish passage after dam removal. The monitoring plan incorporates quantifiable success criteria tracking; ongoing channel geomorphology and fish count surveys; and coordination with NOAA, NHFGD, and NHDES to ensure permit conditions are met. Permit conditions allow for post-construction channel modifications to further restore fish passage. Following the design and permitting phase, the Great Dam was removed from the Exeter River in Summer 2016. The removal process entailed reshaping the river channel at the dam site to optimize conditions for upstream passage of diadromous fish. Ultimately, the dam removal restored 21 miles of the Exeter River and its tributaries to a free-flowing condition, eliminated a barrier to migrating fish, and improved flood resiliency. Post-construction monitoring, now in its third year, indicates that the project is meeting or exceeding all measurable success standards and criteria for fish passage restoration.

9:30 – 10:00AM Two 15-minute presentations will be given during this time slot

Presentation A

Alejandro Molina-Moctezuma (student)[1], Joseph Zydlewski[1,2]
1 Dept. of Wildlife, Fisheries & Conservation Biology, University of Maine, Orono, ME; alejandro.molina@maine.edu
2 U.S. Geological Survey, Maine Cooperative Fish and Wildlife Research Unit, Orono, ME

Historical Movement and Survival of Atlantic Salmon Smolts in the Piscataquis River from 2009-2018

During the last decade, the Piscataquis River (a tributary of the Penobscot River) has undergone important changes that have modified the experiences that Atlantic salmon smolts face during their downstream migration. Predominantly, changes to the Howland Dam, which started seasonal turbine shutdowns in 2010, and was later decommissioned. In 2016, a new nature-like fish bypass was built to increase. From 2009 to 2017 we used acoustic telemetry to understand the passage and survival of downstream migrants. We used detection data and a Cormack-Jolly-Seber (CJS) approach to build a hierarchical multistate model to estimate survival through impounded and un-impounded reaches of the river over this period of time. The use of the CJS approach allowed detection of differences in survival between individual reaches, between years, and between release sites. Reaches that contain dams had lower apparent survival that reaches with no dams. There were differences in survival between years that were associated to environmental conditions (e.g., higher survival during high flows) and changes to the system

(e.g., higher survival at Howland Dam after shutdowns and bypass installation). Release site also affected survival estimates, with fish released further upstream having lower survival at downstream sites. This may indicate a latent effect of previous dam passage.

Presentation B

Matthew Mensinger (student)[1], Joseph Zydlewski[1,2], Erik Blomberg[1]
1 Dept. of Wildlife Fisheries & Conservation Biology, University of Maine, Orono, ME; matthew.mensinger@maine.edu
2 U.S. Geological Survey, Maine Cooperative Fish and Wildlife Research Unit, Orono, ME

American Eels Incur High Mortality at Dams During Seaward Migration in the Penobscot River

American eels, *Anguilla rostrata*, embark on one of the most expansive spawning migrations of any diadromous fish species in the fall. Following metamorphosis from a yellow eel into their final, silver-stage, migrants travel thousands of kilometers from freshwater systems across eastern North America, through estuarine habitat and into the Sargasso Sea. During the freshwater segment of this migration event, eels are often forced to navigate through hydroelectric dams, exposing individuals to turbine-related mortality risks during dam passage. To understand the effects of dam passage in the Penobscot River during this life-cycle stage, we captured and implanted acoustic telemetry tags into 100 silver-stage eels annually from 2016-2018 (n= 300). Tagged eels were immediately transported and released at two different locations upstream of Milford and West Enfield dams. These fish were tracked with an extensive acoustic receiver array as they migrated downstream towards the ocean. The sequence of detections was used to describe patterns of movement and to estimate patterns of survival through impounded and un-impounded reaches in the river. Movements of these fish were slowed by dams and higher mortality was observed in reaches with dams.

10:00 – 10:30AM Two 15-minute presentations will be given during this time slot

Presentation A

Michael Chelminski, David Huntress
Stantec Consulting Services Inc.; michael.chelminski@stantec.com

Revisiting the Blackman Stream Fishway at Leonard's Mills

The fishway on Blackman Stream at the Maine Forest and Logging Museum in Bradley, Maine was constructed in 2009 and commissioned in 2010. The target fish species is alewife (*Alosa pseudoharengus*), and the location of the confluence of Blackman Stream with the Penobscot River provided an opportunity to benefit from the (then) proposed removal of Veazie Dam as part of the Penobscot River Restoration Project. Removal of Veazie Dam restored volitional upstream passage for fish to the confluence of Blackman Stream, and numbers of alewife at Leonard's Mills has gone from virtually no alewife prior to the removal of Veazie Dam to more than 500,000 in 2018.

This presentation revisits identified design opportunities and constraints that were considered in the development of the implemented design, including two previous designs that were developed but not constructed. Construction of this fishway represented the completion of long-term efforts by agency and non-governmental organizations to install upstream fish passage at this site at the downstream end of Chemo Pond, where a number of proposed designs were previously developed but not advanced for construction due to constraints including aesthetic concerns related to impacts to the historic context of the site and the relatively poor condition of the dam and potential effects of fish passage construction and operations on the dam.

Session 9: Migratory Fish Passage

A item of particular relevance is the identified need to increase the capacity of the fishway to accommodate returns that are approximately double the design capacity.

Presentation B

Erin Peterson (student)[1], Joseph D. Zydlewski[1,2]
1 Dept. of Fisheries, Wildlife, and Conservation Biology, University of Maine, Orono, ME; erin.peterson1@maine.edu
2 U.S. Geological Survey, Maine Cooperative Fish and Wildlife Research Unit, Orono, ME

American Shad Demography and Motivation: A Re-Evaluation of Penobscot River American Shad Post Dam Removal

The Veazie Dam (rkm 47) restricted anadromous American Shad *Alosa sapidissima* to spawning habitat in the tidal estuary of the Penobscot River. Prior to the removal of the Veazie Dam in 2013, these spawners had a relatively old age distribution (4-9 years, average 5.8 years) and exhibited high levels of iteroparity (up to 5 spawns). These results were attributed to the short migratory distance and the absence of mortality associated with post-spawn down-stream dam passage. It has been hypothesized that the removal of two dams and improved connectivity to the upper Penobscot River will increase population levels, but also eventually shift population demographics to younger fish with less repeat spawning because of dam passage. Additionally, those fish using newly accessible upstream habitat may tend to be naïve fish rather than previous spawners. We re-examined the age structure and iteroparity rates of spawners in 2018 and compared ages and iteroparity rates for shad sampled below Milford Dam (now the lowermost dam; rkm 61) and fish that successfully passed Milford Dam using scale analysis. The mean age of spawners sampled in 2018 is 4.2 years. Both age and number of spawns were higher for fish sampled below the dam than for fish that successfully passed the dam (4.4 versus 4.2 years, and 0.7 versus 0.4 spawns, respectively). These results suggest that younger fish are accessing the newly available habitat; motivation may be a factor of age and experience.

1:30 – 1:55AM

Jacob T. Aman[1], Michael T. Kinnison[2], Vaughn Holmes[2], Claire Gottsegen[1]
1 Wells National Estuarine Research Reserve, Wells, ME; jacobaman@wellsnerr.org
2 University of Maine, Orono, ME

Developing Cost Effective Monitoring for Rainbow Smelt Using eDNA

Environmental DNA (eDNA) tools developed at the University of Maine, Orono were successfully deployed in four streams in Casco Bay, ME in spring 2018 to detect the presence of anadromous rainbow smelt (Osmerus mordax), the first such application of this emerging technique. Field methods were refined and tested at sites with documented high (2) and low (2) spawning productivity. Samples were collected below known spawning areas near head-of-tide approximately 2-3 times each week during the spawning season. Samples were filtered and preserved for eDNA analysis. Initial efforts to extract DNA from samples were hampered by the presence of environmental inhibitors. Use of soil extraction kits appears to have overcome this problem and eDNA samples have been amplified successfully using quantitative polymerase chain reaction (qPCR). In partnership with a qualified lab, these tools provide a low-cost and user-friendly method for monitoring the presence of rainbow smelt, a priority species for fisheries managers and conservation organizations.

Session 9: Migratory Fish Passage

2:00 – 2:25PM

Katherine A. Littrell (student)[1], David Ellis[2], Stephen R. Gephard[2], Andrew MacDonald[1], Eric Palkovacs[3], Kerry Reid[3], Katherine Scranton[4], David Post[1]
1 Yale University, New Haven, CT; katherine.littrell@yale.edu
2 Connecticut Dept. of Energy and Environmental Protection, Hartford, CT
3 University of California Santa Cruz, CA
4 University of California Los Angeles, CA

River Restoration Project Mediates Secondary Contact between Anadromous and Landlocked Alewife

Fish passage projects are altering habitat connectivity for many anadromous fish species, increasing the chance that previously isolated populations will come into contact. A recent fish passage project at Rogers Lake in Old Lyme, Connecticut, has brought anadromous and landlocked alewife (Alosa pseudoharengus) into secondary contact. The ecological and evolutionary outcomes of secondary contact between alewife life histories may be complex due to their divergent ecology, morphology, and migratory ability. Using a combination of field surveys and mesocosm experiments, we quantified two possible outcomes of secondary contact: the potential for hybridization and competition between alewife life histories for zooplankton. Hybridization potential was examined using otolith-derived spawning probabilities from five alewife populations (2013-2015). We detected low (less than 15%), but variable levels of overlap in spawning time between alewife life histories, with anadromous alewife spawning earlier and over a shorter duration than landlocked alewife. Following secondary contact, we genetically analyzed samples of juveniles each year and detected the production of anadromous alewives starting in 2016 and hybrids in 2017 and 2018. We also conducted two field mesocosm experiments to determine the outcome of competition for zooplankton between alewife life histories. The results indicated that anadromous alewife grew faster than landlocked alewife when zooplankton were abundant, but landlocked alewife may have had a competitive advantage when zooplankton were scarce. The interplay between hybridization and competition with landlocked alewife after secondary contact may have significant ecological and evolutionary implications for the successful management of anadromous alewife populations.

2:30 – 3:00PM

Break – Auditorium

3:00 – 3:30PM Two 15-minute presentations will be given during this time slot

Presentation A

Sarah Rubenstein (student)[1], Joseph Zydlewski[1,2], Nishad Jayasundara[3], Paul Christman[4]
1 UMaine, Dept. of Wildlife, Fisheries, and Conservation Biology, Orono, ME; sarah.rubenstein@maine.edu
2 U.S. Geological Survey, Maine Cooperative Fish and Wildlife Research Unit, Orono, ME
3 University of Maine, Department of Marine Sciences, Orono, ME
4 Maine Department of Marine Resources, Augusta, ME

Energetic Impacts of Passage Delays in Migrating Adult Atlantic Salmon

New England Atlantic salmon runs in the Penobscot and Kennebec Rivers of central Maine have been declining since the 1800s and now face critical endangerment. Despite extensive restoration efforts, inefficient fishways at

dams continue to act as a barrier to fish movement during upstream spawning migrations. The current passage performance criteria at Milford Dam in Milford, Maine, on the Penobscot River is 95% passage within 48 hours of approach, but long delays of weeks at a time are common. Passage delays at dams expose fish to elevated water temperatures causing increased metabolic demand, but there currently exists no clear quantification of metabolic costs and fitness risks associated with these delays. Using a Distell Fish Fatmeter and radio telemetry techniques on the Penobscot and Kennebec Rivers, we have seen patterns of delays at fish passage structures and correlations between fat loss and time spent delayed below the dam. We are characterizing these specific energetic costs of delays to upstream migrating adult salmon with bioenergetics modeling informed by our field work.

Presentation B

Josh Royte[1], **Alicia Heyburn**[2], **Molly Payne Wynne**[1]
1 The Nature Conservancy and World Fish Migration Day Ambassador; jroyte@tnc.org; molly.paynewynne@tnc.org
2 World Fish Migration Day volunteer and citizen concerned for anadromous fish; alicia.communityworks@gmail.com

A Year and a Day for Salmon: Local to Global Outreach Events Raising Awareness for Migratory Fish

Salmon is far more than a topping for a bagel. It is a species that links our forests, via our rivers to the sea, an indicator of healthy habitat and connectivity, and like most fish are victims of stream barriers. Unfortunately, salmon are more known for their flavor than their lifecycle. Two global events are working to change that; International Year of the Salmon (IYS) in 2019, and World Fish Migration Day (WFMD) May 16th, 2020. Both highlight research, environmental action and events that raise awareness, appreciation and advocacy for free-flowing rivers and migratory fish. Salmon are threatened by environmental change and human development across the Northern Hemisphere. The epic migrations of salmon through rivers and oceans take them across many borders and cultures. Saving these beautiful creatures requires a uniquely large-scale solution. IYS sets out to bring countries together to share knowledge, raise public awareness and take action.WFMD is a global celebration to create awareness and connect people to protect and restore free flowing rivers and migratory fish. In 2018 there were events in 64 countries reaching over 10 Million people through social media. Everyone can create and join a celebration. This presentation is for community advocates, fish friends, outreach coordinators, advocates and educators. Will share stories about how these events came to be, examples and ideas on how you and your community can participate and what this work looks like globally to realize the WFMD slogan; "connecting river, people and fish".

3:30 – 4:00PM Two 15-minute presentations will be given in this time slot

Presentation A

Elizabeth Bishop-Hyslop, Rebecca Goreham
St. Croix International Waterway Commission; director@stcroix.org

River Herring Population in the St. Croix River: Fish Counts at Milltown Dam

Fish count data has been collected annually beginning in 1981. We have identified three historical events that have demonstratable effects on the migration of river herring, Alewife (*Alosa pseudoharengus*) and blueback herring (*A. aestivalis*), populations in the St. Croix River. We can demonstrate the improved population growth after measures were initiated to facilitate the successful passage of fish through various ladders.

The first event occurred in 1981. For decades prior to the 1980s, inadequate fish passage at dams on the St. Croix prevented access to spawning habitat and the herring population declined. In 1981 these issues were addressed, and the river herring population quickly increased from 200,000 to a peak of 2.6 million in 1987.

Next, in 1995, due to pressure from Maine fishing guides over a shrinking population of smallmouth bass, Maine Legislature blocked fish passage at the Woodland and Grand Falls dams. The river herring population could no longer reach their spawning grounds, and the herring population in the river crashed from 1.5 million fish in 1990 to 900 fish in 2002.

And the third event occurred in 2013. Due to a lack of evidence that river herring were responsible for a decline in game fish, herring passage was restored allowing the herring populations to steadily increasing in the St. Croix River.

The SCIWC continues to count river herring each season, monitoring the changes increased fish passage brings to river herring population in the St. Croix river.

Presentation B

Daniel Weaver[1], Michael Brown[2], Joseph Zydlewski[1,3]

1 Dept. of Wildlife, Fisheries and Conservation Biology, University of Maine, Orono, ME; daniel.weaver@maine.edu

2 Maine Department of Marine Resources, Augusta, ME

3 U.S. Geological Survey, Maine Cooperative Fish and Wildlife Research Unit, Orono, ME

Where There's a Will, But Not a Way: Behavior of American Shad Approaching the Brunswick Dam Fishway on the Androscoggin River, Maine

Brunswick Dam impedes fish passage in the Androscoggin River at the head of tide and blocks approximately 32 km of spawning habitat for American shad. A vertical slot fishway was constructed at the dam and is intended to facilitate passage for migrating American shad and other anadromous fish. However, numbers of American shad that pass through the dam annually have been relatively low (0 – 1,100 fish) relative to downstream abundance. We analyzed video and telemetry data collected by the Maine Department of Marine Resources from 2002-2005 to evaluate American shad behavior approaching and the fishway relative to hydropower turbine operations. Video analysis revealed relatively high numbers of observations in the river (averaging 50,000) compared to the entrance of the fishway or its pools (<8,000). Rates of observed shad on the side of the river containing the fishway were on average higher (6.5 – 8.6 fish/minute) when the turbine closest to the entrance of the fishway was not operating compared to when it was operating (4.1 fish/minute). Most of the radio tagged shad (75%) never approached the fishway and remained in the river below the dam (or went undetected). Individuals that were detected usually made multiple attempts at entering the fishway, but movements were restricted to the lower pools. Our results suggest that this fishway is not conducive to the passage of American shad. A better understanding of passage delays may contribute to improvement of this fish passage facility.

Session 10 (Afternoon Session)

The Saco Watershed Collaborative – Strategies for Sustainability in Southern Maine's Largest Watershed

The 1,700 square mile Saco Watershed provides food, fiber, drinking water, renewable energy and recreational opportunities for thousands of people. The ecosystem services of the watershed support livelihoods, communities and businesses in Maine and New Hampshire and contribute to strongly held values connected to sense of place throughout the region. For three years a diverse and dedicated group of partners have worked to build the Saco Watershed Collaborative to sustain what people value most about the watershed. This session will highlight the strategies used to build the diverse membership of the Collaborative, challenges faced, and plans for the future, highlighting lessons learned relevant to all watershed groups.

** 2 credits are available for this session through APA AICP*

Session Overview

1:30PM – 1:55PM Chris Feurt
Using Sustainability Science to Build the Saco Watershed Collaborative

2:00PM – 2:25PM James Innes
Facing New Challenges in Forest Management for Water Protection

2:30PM – 3:00PM Break (Auditorium)

3:00PM – 3:25PM Rick Knowlton
The Business of Clean Water A Model for Watershed Collaboration

3:30PM – 3:55PM Dalyn Houser
The History of the Saco River Corridor Commission: How Citizens of Our Own Communities Work to Preserve Land and Water Quality

Session 10: The Saco Watershed Collaborative

Session Chair & Moderator

Chair: Chris Feurt
Wells National Estuarine Research Reserve and University of New England; cfeurt@une.edu

Moderator: Robyn Saunders
Saco Watershed Collaborative; robyn@attaining.me

Chris Feurt has worked with members of the Saco Watershed Collaborative since 2016. She contributed to the formation of the group and the development of the group's Action Plan. She is the Coordinator of the Sustainable Communities Collaborative in the Department of Environmental Studies at UNE. She teaches courses in Sustainable Water and Environmental Communication. She is also the Director of the Coastal Training Program at the Wells Reserve. Her work focuses on stakeholder engagement, coastal management and applying sustainability science to watershed management.

Robyn Saunders, the new project manager for the Saco Watershed Collaborative, brings 20+ years of technical experience to the group of diverse stakeholders in Maine and New Hampshire. As a native of Maine and graduate of the University of Maine's Dept. of Civil and Environmental Engineering, she is extremely excited to be working on this multidisciplinary watershed protection project that marries her water resources background with her passion for collaboration. She wishes to thank Drs. Chris Feurt and Pam Morgan, and Emily Greene, Outreach Coordinator for the Saco Watershed Collaborative, for welcoming her to the team of professionals serving the Collaborative.

1:30 – 1:55PM

Chris Feurt
Coordinator, Sustainable Communities Collaborative, University of New England and Director, Coastal Training Program, Wells National Estuarine Research Reserve; cfeurt@une.edu

Using Sustainability Science to Build the Saco Watershed Collaborative

Principles and practices of sustainability science are being used to convene and guide the formation of the Saco Watershed Collaborative. Members of the Collaborative represent diverse organizations with shared goals for sustaining the ecosystem health and benefits of the Saco Watershed. The Saco Watershed with headwaters in the White Mountains of New Hampshire is the largest watershed in southern Maine. Like many Maine Rivers, the Saco is a working river serving industry, business, and recreation. A committed "Stewardship Network" of communities, governments, land trusts, watershed groups and organizations passionate about fish, wildlife, clean water, environmental quality and special places are actively engaged in sustaining the Saco. Creating synergies among this network is a goal of the Collaborative. Competition for the ecosystem services and benefits provided by the Saco creates challenges. Strategies to achieve goals related to fish passage, drinking water, energy production, recreational use, and ecosystem health must be balanced and negotiated. The Collaborative sponsored field trips and meetings designed to educate participants about the different ways that organizations practice stewardship and to develop a sense of shared purpose. A collaboratively developed Action Plan will guide future work and measure the progress of the Collaborative.

Session 10: The Saco Watershed Collaborative

2:00 – 2:25PM

James Innes
Saco District Ranger, White Mountains National Forest, U.S. Forest Service; jinnes@fs.fed.us

Facing New Challenges in Forest Management for Water Protection

The White Mountains National Forest was created over 100 years ago to protect the headwaters of the Saco Watershed. Forest management and forestry research contributed to the reforestation of the headwaters over the decades since the National Forest creation. Current forestry practices follow best practices for watershed protection. Increasing recreation pressure, demands for parking and trail maintenance all have water quality impacts. A new challenge emerged with the Halloween storm of 2017. Extreme precipitation impacts washed out a bridge, road and flooded nearby communities. Following this event, the U.S. Forest Service completed a hydrologic study and is working to plan for future extreme weather events. Dam removal, habitat improvement and cultivating conservation partnerships like the Saco Watershed Collaborative are all part of the U.S. Forest Service approach to sustaining the Saco watershed.

2:30 – 3:00PM

Break – Auditorium

3:00 – 3:25PM

Rick Knowlton
President, Maine Water Company; rknowlton@mainewater.com

The Business of Clean Water A Model for Watershed Collaboration

The Maine Water Company is a public water utility that currently owns or manages 13 water systems engaged in the collection, treatment, and distribution of potable water for homes, businesses and fire protection services. The Maine Water Company serves more than 32,000 customers (approximately 80,000 residents) in 21 Maine communities. The Saco River is the source water for the Maine Water Company's operations in Biddeford and Saco. Plans are underway for building an updated water treatment facility in Biddeford. The Maine Water Company provides both expertise and financial support for the Saco Watershed Collaborative. The Biddeford water treatment plant has hosted numerous tours to educate members of the Collaborative about the importance of source water protection and the implications for water treatment when the quality of Saco River water is impacted by land use practices and extreme precipitations events.

3:30 – 3:55PM

Dalyn Houser
Executive Director, Saco River Corridor Commission; dalyn@srcc-maine.org

The History of the Saco River Corridor Commission: How Citizens of Our Own Communities Work to Preserve Land and Water Quality

Over 46 years ago, citizens concerned over improper and incompatible development of the Saco River Corridor approached the Maine State Legislature. They were deeply concerned about the occurrence of environmental degra-

Session 10: The Saco Watershed Collaborative

dation to the lands and waterways of the Corridor and the loss of the current cultural values present in Southern Maine. After two years of extensive research of the unique natural resources present in the Corridor, the Saco River Corridor Act was established in 1973 in order to protect the integrity and quality of the waterways and lands of the Corridor.

The purpose of the Commission is to preserve the existing water quality of the Saco, Ossipee and Little Ossipee Rivers and protect public health, safety, and the quality of life for the State of Maine through the regulation of land and water uses, protection and conservation of the region's unique and exceptional natural resources, and through the prevention of impacts caused by incompatible development.

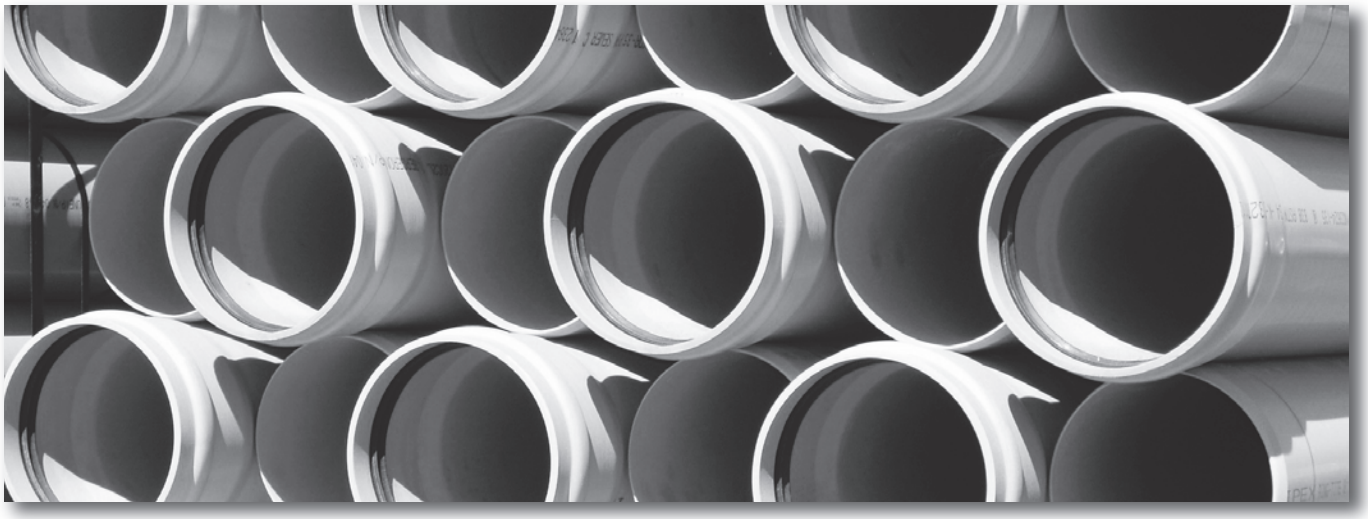
The same is true today that was true in 1973, the Commission provides a comprehensive protection to the land and waterways of the Corridor unlike any other federal, state or local regulation. The foundation of the Act was established purposefully, in order to keep the decision-making power of the development occurring in our communities in the hands of the local people. The regulations and standards of the Saco River Corridor Act are carried out by members of our own communities who volunteer their time to ensure proper development and secure the Maine natural shoreline.

Session 11 (Afternoon Session)

Where Will the Money Come From? Upgrading Infrastructure for Wastewater Treatment Facilities

Maine has 162 municipal and quasimunicipal wastewater treatment facilities with associated sewer lines and pump stations. In addition, Maine has 41 satellite sewer collection systems. This infrastructure conveys and treats wastewater from homes and business and is essential to protect and improve the waters of the state. There is an existing need of approximately $1 billion dollars to upgrade this infrastructure as it comes to the end of its useful life and to abate combined sewer overflows from combined sanitary and stormwater sewers. This panel discussion will provide a brief overview of this infrastructure, current financial needs and funding options, and explore new ways to fill the current funding gap.

** 2.5 credits are available for this session through APA AICP*
** One presentation in this session has been approved for training contact hours (TCH) through the State of Maine Board of Licensure of Water System Operators. Please see below for details.*
** This session have been approved for 1 training contact hour (TCH) through Maine's Wastewater Operator Certification Program.*



Session Chair

Brian Kavanah
Acting Co-Director, Bureau of Water Quality, Director, Division of Water Quality Management, Maine Department of Environmental Protection; Brian.W.Kavanah@maine.gov

Brian Kavanah has worked in the field of environmental protection for 32 years, holding a variety of positions with the Maine Department of Environmental Protection and briefly with the U.S. Environmental Protection Agency in New York City. Since 2001, Brian has served as the Director of the Division of Water Quality Management (DWQM) at the Maine DEP. Since July 1, 2018, he is also serving as Acting Co-Director of the Bureau of Water Quality. The DWQM is responsible for all regulatory programs for point source wastewater discharges, and point source stormwater discharges, including: licensing, compliance, technical assistance, enforcement, pretreatment, combined sewer overflows, State Revolving Fund and Grants, overboard discharge regulation and removal, and Small Community Grants for the replacement of septic systems. In addition, the DWQM administers the boat pump out, No Discharge Area, sand & salt pile, and underground injection control programs.

Session 11: Upgrading Wastewater Infrastructure

One hour session - 1:30 – 2:30PM

Panel Discussion

1:30 - 1:45PM
Introductions and Overview of Wastewater Infrastructure in Maine
Brian Kavanah, Maine Department of Environmental Protection

1:45 - 2:05PM
Financial Challenges of a Small Town
Annaleis Hafford, P.E. Olver Associates Inc.

2:05 - 2:25PM Approved for 0.5 TCH for Water System Operators
The Challenges of Bonding: Experience of the Last Legislative Session.
A New Approach: LD 347 – "An Act to Provide Sustainable Funding for Drinking Water and Wastewater Infrastructure"
Tim Haskell, Maine Water Environment Association (MEWEA)

2:25 - 2:30PM
Questions/Comments

Session 12 (Afternoon Session)

UMaine's Forest Climate Change Initiative: An Overview and Discussion

The University of Maine's Center for Research on Sustainable Forests has recently initiated an effort to better coordinate regional research and scientists working on the potential effects of climate change on forests. This session will highlight the goals of this initiative and begin a larger discussion on research priorities. In particular, the session will feature an overview of current Forest Climate Change Initiative activities, presentations on the current state of knowledge across multiple disciplines, and a panel discussion of stakeholders on their experiences and information needs regarding emerging weather patterns and climate change. A facilitated open discussion will follow to identify and prioritize information needs and research priorities.

** The Society of American Foresters has approved 1.5 Category 1 CFE credits for this session*

Session Chair

Aaron Weiskittel
Director, Center for Research on Sustainable Forests, University of Maine; aaron.weiskittel@maine.edu

1:30 – 2:30PM Presentations

Overview of the Forest Climate Change Initiative (FCCI)

Aaron Weiskittel, *University of Maine Center for Research on Sustainable Forests; aaron.weiskittel@maine.edu*

This presentation will include an outline of potential regional sources of information, current resources provided by FCCI, and plans for FCCI moving forward.

Aaron Weiskittel is the Director of the Center for Research on Sustainable Forests and Professor of Forest Biometrics & Modeling in the School of Forest Resources at the University of Maine. His research has been focused on developing a new growth and yield model for the Acadian Region, evaluating stem taper/volume equations, and exploring the potential influence of climate change on forest productivity. He has a Bachelors of Science in Natural Resources from The Ohio State University and Masters of Science in Forest Resources as well as a Doctorate in Philosophy in Forest Science from Oregon State University. He has been at the University of Maine since 2008 after working for Weyerhaeuser.

Session 12: UMaine's Forest Climate Initiative

Evidence for a Changing Physical and Chemical Climate in Maine

Ivan Fernandez, *University of Maine School of Forest Resources and Climate Change Institute; ivanjf@maine.edu*

This presentation will provide an overview of current and predicted changes in Maine's climate based on regional observations and projections. It will highlight the broader implications of these changes and influence on the larger economy.

Ivan Fernadez is the Distinguished Maine Professor of Soil Science in the School of Forest Resources at the University of Maine (UMaine). He is a soil scientist with interests in the biogeochemistry of forested ecosystems in a changing chemical and physical climate. He is also interested in how we are developing adaptation strategies for managing ecosystem response to climate change, particularly as it relates to terrestrial ecosystems and the freshwater resources they encompass. He has a B.A. in Biology from Hartwick College, and a M.S. in Plant & Soil Sciences as well as a Ph.D. in Forest Resources from University of Maine. He has been a faculty member since 1983 after working for the National Council of the Paper Industry for Air and Stream Improvement.

Current State of Knowledge and Research on Potential Effects of Climate Change on Forest Ecology

Jay Wason, *University of Maine School of Forest Resources; jay.wason@maine.edu*

This talk will explore the current understanding of the physiological response of trees, forests, and the larger ecosystem to expected changes in future climate. Particular focus will be on broader implications and suggestions to land managers.

Jay Wason is the Assistant Professor of Forest Ecosystem Physiology in the School of Forest Resources (SFR) at UMaine. Before joining SFR, Dr. Wason was a postdoctoral associate at the Yale School of Forestry & Environmental Studies. His research uses lab and field studies to determine the physiological responses of northeastern forest trees to novel future climate conditions. He has a B.A. from the University of Pittsburgh and a Ph.D. from SUNY College of Environmental Science and Forestry.

Current State of Knowledge and Research on Potential Effects of Climate Change on Forest Economics

Adam Daigneault, *University of Maine School of Forest Resources; adam.daigneault@maine.edu*

This presentation will explore the specific implications of climate change on Maine's forest-based economy and linkages to expected changes in the global economy. The focus will be on a broad array of economic factors like fiber, recreation, carbon, and water.

Adam Daigneault is the Assistant Professor of Forest, Conservation, and Recreation Policy in the School of Forest Resources at UMaine. His work has been to develop quantitative models to assess the socio-economic impacts of environmental policy on the natural resource sectors, which includes climate change mitigation and adaptation. He has a B.A. in Economics & Environmental Studies from Denison University and an M.A. in Economics as well as Ph.D. in Environmental & Natural Resource Economics from The Ohio State University. Adam has been a faculty member since 2016 after being a Senior Economist at Landcare Research, New Zealand's leading institute on terrestrial ecosystems and biodiversity research and an Economist for the U.S. Environmental Protection Agency.

Current State of Knowledge and Research on Human Dimensions of Climate Change and Potential Effects on Behaviors Associated With the Use and Management of Forests

Sandra De Urioste-Stone, *University of Maine School of Forest Resources; sandra.de@maine.edu*

This talk will evaluate the role of future climate change on how humans interact with the forest beyond traditional management such as recreation, aesthetics, and cultural identity. This will include factors such as changes in snow cover, more extreme events, and prevalence of tick-borne diseases.

Session 12: UMaine's Forest Climate Initiative

Sandra De Urioste-Stone is the Assistant Professor of Nature-based Tourism in the School of Forest Resources at UMaine. Her interests are in developing collaborative and interdisciplinary research to address what makes some societies and communities more resilient to global and local changes–including climate change. She has a B.A. from Universidad del Valle de Guatemala and a M.S. and Ph.D. from the University of Idaho. She has been a faculty member since 2013, after being a Department Chair, Instructor and Researcher at Universidad del Valle de Guatemala and Ecotourism Program Manager for a conservation non-profit organization in Guatemala working with indigenous/rural communities.Improvement.

2:30 – 3:00PM

Break – Auditorium

3:00 – 4:00PM Panel and Group Discussions

Panel Discussion

Panelists:

Doug Denico, Maine Forest Service – Denico is Director of the Maine Forest Service. Prior to being lured out of retirement to serve as Director, he worked for 27 years for International Paper and Scott Paper Co. in northern Maine. He obtained his Master of Science in Forest Economics and Bachelor of Science in Forest Management from the University of Maine.

Andy Cutko, The Nature Conservancy – Cutko is Director of Science for The Nature Conservancy of Maine. Prior to joining that organization in 2017, he was an Ecologist with the Maine Natural Areas Program within the Maine Department of Conservation. He has a Bachelor of Arts from Williams College and a Master of Forestry from Duke University.

Rex Turner, Maine Bureau of Parks and Lands – Turner is Outdoor Recreation Planner at the Maine Bureau of Parks and Lands and has been in that position since 2008. Prior to that, he was the Director of Education at Maine Lakes Conservancy Institute and a professional outdoor guide. He has a Bachelor of Science in Outdoor Recreation and Master of Forestry, both from the University of Maine.

Marcia McKeague, Acadian Timber (Retired) – As Vice President of Acadian Timber, McKeague was responsible for the operations of Acadian Timber's 300,000 acres of timberlands in Maine. She was also President of Katahdin Timberlands LLC, a company owning and managing over 600 recreational leased lots in Maine. Prior to joining Brookfield in 2003, Marcia managed both the wood procurement activities and the timberlands of Great Northern Paper during the time that the company owned two million acres and operated a sawmill and two pulp and paper mills. Marcia has over 30 years of experience in the forest industry primarily in planning and operations management functions. She has a B.S. in Forestry from the University of Michigan and a M.S. in Forestry from Michigan State University and is a licensed professional forester in Maine.

Facilitated Group Discussion

Moderator: Nick Fisichelli, Schoodic Institute

Research needs and priorities.

Session 13 (Afternoon Session)

The Literature of Water: Poetry & Prose by Maine writers

This humanities panel will be a discussion of prose and poetry relating to Maine rivers, lakes and coastal regions and will include readings by several notable writers and poets of Maine.

1:30 – 4:00PM

Break: 2:30-3:00PM (Auditorium)

Session Participants: Gary Lawless, Paul Molyneaux, Kathleen Ellis, Dana Wilde (Co-chair), Hugh Curran (Co-chair)

Gary Lawless is a native of Belfast, Maine. He is co-owner of Gulf of Maine Books in Brunswick (Maine) and a widely published poet, with 21 published collections of poetry (five of them in Italy, in Italian). He has had artist residencies in Sitka, Alaska, Isle Royale National Park in Lake Superior, and in southern Labrador. He spent the fall of 2017 in Venice, Italy with an artist residency from the Emily Harvey Foundation. He has an honorary Ph.D. from the University of Southern Maine (Humane Letters) and is currently the Maine Humanities Council Constance Carlson Fellow. He and his wife Beth live in Nobleboro as caretakers of Chimney Farm, the Maine home of authors Henry Beston and Elizabeth Coatsworth. Gary's poetry rises out of interests in bioregionalism and watershed awareness. He and poet Karin Spitfire performed a touring "sardine songs" program in Port Clyde, Belfast, Bass Harbor, and at the Maine State Museum, from which Gary's poem below is a small segment:

sardine plant, Belfast
May we be blessed by
the spirits of these fish
swimming through our world
from the world above
from the world below
rising from the depths
of our future
blessing the depths
of our past

Session 13: The Literature of Water

Paul Molyneaux - Veteran commercial fisherman, Paul Molyneaux is the author of *The Doryman's Reflection: A Fisherman's Life*; *Swimming in Circles: Aquaculture and the End of Wild Oceans*; and *A Child's Walk in the Wilderness*. He has written about commercial fishing for the New York Times and other publications, and won a 2007 Guggenheim Fellowship to study sustainable fisheries in India, Chile, Iceland and several other countries. He lives in Maine and Mexico.

Excerpt from "The Doryman's Reflection"
2007 Simon & Schuster

Nonetheless, by the prevailing measures, finfish aquaculture still looks like a winner, and entrepreneurs eager to invest in aquaculture believe they have solved the problems that plagued salmon farming by moving to the new frontier: the open ocean.

Complete with rhetoric that sounds hauntingly familiar from the rapid expansion of the fishing fleet in the 1970s, open ocean aquaculture proponents trumpet the vast capacity of the offshore waters to support fish farming. Speaking in 1996 at an international Sea Grant conference on open ocean aquaculture, Jill Fallon, executive director of The Aquaculture Coalition, went so far as to call aquaculture "manifest destiny" and compare the fishermen to Native Americans. "This is not the time or the place to discuss the tragedy of the American Indian," said Fallon, in her racist diatribe. "They had to be removed, warred against, and eventually forced onto reservations in order to make room for settlers thirsting for land." In that same spirit, she urged, "We must open the Blue Frontier." If all goes according to plan, open ocean fish farmers and their allies in government would leave fishermen like Bernard with an ever shrinking and damaged piece of the ocean. As had happened with the Native Americans, the Acadians, and now the fishermen, those with the technology and capital appropriated the resources from those without.

With help from Sea Grant, several commercial open ocean fish farms were already established by 2003. A company called Snapperfarm grew cobia in submerged net pens near Puerto Rico. Snapperfarm owner Brian O'Hanlon would later take his operation to Panama, where National Geographics Magazine described him of creating his fish farm "out of nothing, in the middle of nowhere," ignoring the federal grants O'Hanlon had received and apparently crediting him with powers of alchemy. In New Hampshire, fishermen from the Portsmouth Fishermen's Co-op became participants in creating their own obsolescence. They joined a private company, Great Bay Aquafarms, of Newington, New Hampshire, and the University of New Hampshire, as leaseholders in an open ocean aquaculture project that will grow cod in submerged pens.

In spite of the fact that cod near Eastport, Maine were identified as carriers of ISA, and that fish farms are known disease incubators, scientists with NMFS, the primary agency responsible for managing open ocean aquaculture, dismiss the risk of spreading disease to wild cod. "There is virtually no risk," said Linda Chaves, spokesperson for NMFS.

"We haven't even thought about it," said Chris Duffy, vice president of Great Bay Aquafarms. Like most fish growers, he focuses on what happens inside, not outside, the pens. Speaking at an aquaculture workshop in New Brunswick in the summer of 2003, Duffy predicted vast cod farms in the western Gulf of Maine. "I hope to see cod production on the level of chicken," he said.

Kathleen Ellis is the author of five collections of poetry, most recently *Outer-Body Travel* and *Narrow River to the North*. She teaches English and Honors at the University of Maine, and she has received poetry fellowships from the National Endowment for the Arts and the Maine Arts Commission. She is the recipient of the Pablo Neruda Award from Nimrod and poetry prizes from Carolina Quarterly and Southwest Review. Her poems also appear in three Nations Anthology, The Coastal Companion, The Eloquent Edge:15 Maine Women Writers, and Maine Speaks!

Session 13: The Literature of Water

From 1981-1997, Ellis was communications coordinator for Maine Sea Grant, and in 1998-2000, she was writer/editor for an engineering firm monitoring Superfund base cleanup in the San Francisco Bay Area. Her manuscript of poems, Dear Darwin, was set to music and released as a Parma Recordings CD, which was nominated for a 2015 Grammy award. Ellis has coordinated poetry & science readings for the Maine Science Festival and the 350 International Day of Climate Action, and her long poem Circling Katahdin was set to music and performed by the UMaine chorus in 2005. She lives in Orono near the confluence of the Penobscot and Stillwater Rivers.

Selections from "Narrow River to the North: Poems & Prose of the Penobscot Watershed"
Amapola Books, Bangor, Maine, 2011

The river is various, the world as we find it, without forcing arbitrary
meanings of pastoral loveliness or idyllic withdrawal to a simpler world
upon it. The Penobscot's main stream is often narrow, although it widens
below head of tide at Bangor and again as its East and West branches enter
the highland lakes. The river is oxymoron: quiet and boisterous, dammed
yet ever changing. (p. 12)

— The water is taking shape —
it's not the currents in the river
but the river in the currents. (p. 13)

May 1 — opening day for salmon season on the Penobscot, the first since
1999, catch-and-release only. Fishermen caught some grass, a couple of
sticks, a hunk of Styrofoam, a child's lawn chair. Nobody spotted a house
drift by, but they'd heard that one had slipped off its moorings near
Frenchville and was on its way downstream. You never know what the
river will release. (p. 23)

— Even in its narrowest flows
or standing pools —
the river demands to be heard. (p. 24)

Untitled
When I was eye to eye
with the bottom of the river,
I knew it for what it was: thinking
curves space, makes rocks look
rubber. The eyes of the salmon
see heat, see movement
from above. My eyes, however,
care about color, not heat;
my heart is in the water. (p. 16)

Dana Wilde writes the "Backyard Naturalist and Off Radar" columns for the Central Maine Newspapers. He is a former journalist, university professor, Fulbright scholar, and NEH fellow. His recent books are *Summer to Fall: Notes and Numina in the Maine Woods,* and *Nebulae: A Backyard Cosmography*. *A Backyard Book of Spiders in Maine* is due out this summer from North Country Press. He lives in Troy, Maine.

Session 13: The Literature of Water

Excerpt from Backyard Naturalist essay:

A report a few years ago showed that in 1985 and 2009, the surface temperature of lakes in the Northern Hemisphere "were warming significantly faster than the global average." Whether Maine's lakes were part of the warming was not specified in the report. But I found a raw data sheet of lake water temperatures made available by the Maine Department of Environmental Protection to see if I could get a reliable clue. I couldn't, of course, because I'm not a climate scientist.

But my perusal, anyway, of surface temperatures recorded in mid-July and late August on Cobbosseecontee Lake and Unity Pond showed in both cases fluctuations up and down, year by year with no huge departures between the early 1980s and 2014. But in the 2000s the temperatures for both seemed to be generally a bit higher – more toward the mid 20s Celsius – than the temperatures in the 1980s, which seemed to land more toward the lower 20s. No July or August temperatures during the 2000s dipped to the teens, whereas one August day in 1982 Cobbosseecontee's temperature at the surface was 17.2 degrees, and one August day in 1986 Unity Pond's was 19. Now, temperature data are not the stuff bad dreams are made on. Unless you start turning them over in your brain.

Hugh J. Curran was born in Donegal, Ireland in a Gaelic speaking family and after moving to Canada did undergraduate studies in Nova Scotia, then moved to the U.S. He lived for five years as a Zen monastic and as an assistant to Philip Kapleau, the author of *The Three Pillars of Zen*. After an extensive pilgrimage to India and Japan he moved to Maine and did graduate studies in Irish literature at the University of Maine and became a founding member of the Morgan Bay Zendo where he is on the Board of Directors & guides retreats. He also founded the Friends of Morgan Bay which oversees five nature preserves. During the 1990s, Hugh became the director of a homeless shelter in Downeast Maine and has published articles on homelessness. Since 2002, he has been a lecturer in the Peace & Reconciliation Studies Program at the University of Maine where he teaches courses on Sacred Earth: Ecology & Spirituality as well as Nonviolence; Hugh has co-written a book on local history with Esther Wood and has published poetry in various poetry journals as well as compiling a book for students titled *Excerpts on Nonviolence from Classical to Modern Writers*. In July, 2017, he was invited to present a paper on a "Buddhist Interpretation on the Ethics of Animal Suffering" at St. Stephen's College, Oxford University, UK.

The Three Brothers
Published in Puckerbrush Review

I encountered him as I had often encountered
family lore, unpredictably, as if by chance, the story
of three brothers, riding rough waves in their
small fishing boat.

Now I gazed at him, this lone survivor who
gazed back at me with afflicted eyes while we
stood on the long curving strand next to grass
covered sand-dunes.

His eyes were fixed on me as I asked about
our shared island heritage, while with rough hands
blackened by pitch he bent back to the chore of
repairing the canvas covered boat turned upside-

down, coating the seams with bitumen.
His satisfaction came in the repetitive task,

Session 13: The Literature of Water

a penitence reflected in the slow cadence
of his responses so like my father's island brogue.

In flecked conflicted eyes his spiral of suffering
re-circulated in gaelic intonations, giving through
speech a measure of relief to his long-held emotions.
The sequence of events intoned, the ships bell

sounding in a pea-soup fog beyond Tory Sound,
the three brothers sailing out to catch the
last of the herring run, the shifting turns in the
migratory channels of a passing freighter steaming

through the morning mist, the bell masking their
loud repetitive hallo, the drowning out by engine sounds
of the brothers screams, the thrashing of the backwash
over the low-riding sides of the curraugh.

On the rounded broken back of their boat turned
upside-down, three brothers clung, recounting
family lore to keep at bay the frigid coldness;
And then he became the lone survivor watching

in mute despair as his youthful brothers succumbed
to the waves. Yet he who had gazed at me with such
fatalism, spoke of holding fast, willing his two brothers
to stay above the waves, before he alone was dragged

half-conscious into a fisherman's boat. He had clung to
dreams of those silent screams till the sea scoured his memory,
the blinding mist sweeping over his longing to make
amends for lapsed understanding of passageways & ferryboats.

No sea god could ever bridge the gulf of deep affection
which he conveyed, looking at me mutely, with scabbed
fierceness, his long-held struggle half-buried in anguish
and the need for numb forgetfulness.

I briefly gripped his elbow as his hands pressed down
over the glazed joints, while across his brow a crows-nest
of wrinkles were awash with broken veins webbed upon
cheeks that seemed to trace the story of mythic voyages,

where mourners on islands walked their perpetual circle
of melancholy. In the punctuated equilibrium of an ever-
stretching wake that traced itself over thirty-years
he was still bound to two brothers, clinging to the keel

of this, his memorial boat turned upside down
on the long curved strand of his affliction.

Session 14 (Afternoon Session)

An Interagency Forum on Climate Activities and Needs

The Maine Interagency Climate Adaptation Work Group (MICA) is a State agency interdisciplinary network that facilitates a shared understanding of climate-related issues and resources. Members released the report, Maine Prepares for Climate Change: 2019 Update, and contributed resources to the Maine Climate Clearinghouse and Adaptation Toolkit. Presentations will provide an overview of MICA, highlight action areas underway, and provide a deeper understanding into a few specific activities from agency presenters. Among the topics considered in detail will be habitat implications of climate change, impacts to drinking water supplies, changing peak flows and practical tools for transportation infrastructure, climate change in the State Hazard Mitigation Plan, and other topics.

** 2.5 credits are available for this session through APA AICP*
** Two presentations in this session have been approved for training contact hours (TCH) through the State of Maine Board of Licensure of Water System Operators. Please see below for details.*

Session Overview

1:30PM – 2:00PM Two 15-minute presentations
A. Nathan Robbins
Interagency Climate Coordination
B. Sophia Scott (0.5 TCH)
Cyanobacteria, Cyanotoxins, and Climate: Potential Impacts to Drinking Water in Maine

2:00PM – 2:25PM Amanda Shearin and Tim Spahr
Wildlife Conservation Actions for a Changing Climate

2:30PM – 3:00PM Break (Auditorium)

3:00PM – 3:25PM Charlie Hebson
GIS Tool for Simple Resilience Assessment of Highway Corridor Culverts

3:30PM – 3:55PM Anne Fuchs
Climate Change and Hazard Mitigation

4:00PM – 4:30PM Panel Discussion (0.5 TCH)
Nathan Robbins, Sophia Scott, Amanda Shearin, Tim Spahr, Charlie Hebson, Ryan Gordon

Session 14: Interagency Forum on Climate Activities

Session Co-Chairs

Nathan Robbins
Maine Department of Environmental Protection, Augusta, ME; nathan.p.robbins@maine.gov

Robert Marvinney
Maine Geological Survey, Augusta, ME; robert.g.marvinney@maine.gov

Nathan Robbins is the Climate Change Specialist for the Maine Department of Environmental Protection. He studied Biology at Wheaton College and received a M.S. in Resource Management and Conservation from Antioch University of New England. Nathan has worked in state and local governments, for non-profits, and with private businesses on partnership building, informed decision making, community engagement, and sustainable resource management practices for the past 10 years. He currently focuses on integrating climate information into agency practices, programs, and initiatives. This includes to liaise and coordinate with agencies and partners, to serve on state and regional groups, and to provide climate services assistance to individuals, communities, and areas impacted by climate change.

Robert Marvinney has been with the Maine Geological Survey since 1987 and has been Director and State Geologist since 1995. Marvinney began his work in Maine geology while a graduate student at Syracuse University, completing Master's and Ph.D. projects based on mapping in Maine. He runs a multi-faceted agency with programs in basic geologic mapping of Maine's bedrock and surficial deposits, coastal geology and processes, groundwater investigations, and geologic hazards. He frequently speaks before Legislative Committees on geological issues, most recently focusing on ground water resources and their appropriate management.

1:30 – 1:55PM Two 15-minute presentations will be given during this time slot

Presentation A

Nathan Robbins
Maine DEP Climate Program, Augusta, ME; nathan.p.robbins@maine.gov

Interagency Climate Coordination

Representatives from nine departments, agencies, and offices make-up the Maine Interagency Climate Adaptation Work Group (MICA). Over the past few years the group has focused on raising awareness of existing resources, activities, and of where technical expertise can be accessed. Several strategies and actions have been identified that the group and its participating agencies anticipate pursuing in the months and years ahead.

Presentation B

Sophia Scott
Maine CDC Drinking Water Program, Augusta, ME; sophia.scott@maine.gov

** Approved for 0.5 TCH*

Cyanobacteria, Cyanotoxins, and Climate: Potential Impacts to Drinking Water in Maine

Cyanobacteria, also known as blue-green algae, can produce toxins that negatively impact human health and pose a threat to public water systems. This emerging contaminant rapidly reproduces in nutrient-rich, warm surface waters, forming blooms that are commonly referred to as harmful algal blooms. Across the country, drinking water

systems have been impacted by large-scale cyanobacteria events – affecting millions of Americans. Scientists predict that changing climatic conditions, such as warming water temperatures and increased heavy precipitation events, will increase the frequency of cyanobacteria blooms.

To better understand the risk posed to Maine's drinking water systems supplied by surface water, the Maine CDC Drinking Water Program embarked on a study of cyanobacteria in 2017. The study concluded that Maine's drinking water systems remain relatively unimpacted by cyanobacteria. However, it is important that Maine's public water systems remain vigilant and maintain diligent drinking water protection measures to ensure the continued provision of clean, safe drinking water for all Mainers.

2:00 – 2:25PM

Amanda Shearin[1], **Tim Spahr**[1]
1 Maine Dept. of Inland Fisheries & Wildlife, Bureau of Resource Management, Augusta, ME; amanda.f.shearin@maine.gov
2 Maine Dept. of Inland Fisheries & Wildlife, Maine Warden Service, Augusta, ME; tim.spahr@maine.gov

Wildlife Conservation Actions for a Changing Climate

The Maine Department of Inland Fisheries and Wildlife and our conservation partners assess the health of Maine's fish and wildlife populations every ten years. These findings are published in Maine's Wildlife Action Plan. The 2015-2025 Wildlife Action Plan identifies 378 species in greatest need of conservation. Of these, over 25% are significantly affected by changing climates. If agencies and partners take action now to conserve these species and their habitats, we can halt further declines.

The Maine Warden Service is the bureau of the Department of Inland Fisheries and Wildlife responsible for natural resource law enforcement, wilderness search and rescue and mitigating human/wildlife interaction. Out of the 8,725 public complaints handled by Warden Service in 2018, 3,686 or 42 percent were nuisance wildlife to include dead wildlife and rabies specimens. Data collected in 2016 showed a three-year average (2014-2016) of 2,112 nuisance wildlife calls. This information suggests longer summers and warmer winters are resulting of extended periods of wildlife activity and shifts in wildlife migration. Game wardens are now spending more time responding to nuisance wildlife and less time enforcing natural resource laws.

2:30 – 3:00PM

Break – Auditorium

3:00 – 3:25PM

Charles Hebson
Maine Dept. of Transportation, Environmental Office, Augusta, ME; charles.hebson@maine.gov

GIS Tool for Simple Resilience Assessment of Highway Corridor Culverts

Road culverts are typically designed for a specified peak flow annual exceedance probability Pex (or return period T). Developments in hydrology and hydraulics software over the past few years have greatly simplified the culvert sizing process, yet sizing still takes place on a project-by-project, location-specific basis. Thus, standard analysis methods are unsuitable for system-wide resilience assessment. MaineDOT has combined hydrology (StreamStats)

and hydraulics (HY-8) tools with a comprehensive statewide culvert/bridge database so that simple H&H results are available for practically every stream crossing in the MaineDOT system. The results indicate culvert capacity according to current design standards as well as required size to comply with those standards. These results are immediately useful for routine project planning and as input to preliminary design and can form the basis for future system-wide resilience assessment. The basic methodology is applicable to any culvert/bridge database and a related tool is currently being piloted with several municipalities around the state by the Environmental Finance Center at University of Southern Maine/Muskie School.

3:30 – 3:55PM

Anne Fuchs
Maine Emergency Management Agency, Hazard Mitigation, Augusta, ME; anne.p.fuchs@maine.gov

Climate Change and Hazard Mitigation

For decades flood and storm damage have had devastating impacts on communities across the State of Maine. As rising sea levels and storm frequency become increasingly impactful to Maine communities, Maine Emergency Management Agency has taken a proactive role in working with the scientific community and local emergency management officials to accurately identify and address these changes across coastal and riverine communities. The State Hazard Mitigation Plan is a tool that identifies statewide hazards and acknowledges the State's commitment to strategically mitigate risk. This session will discuss our State's Plan as it pertains to climate change, and risk-reduction grant opportunities available to non-profit organizations, state government, local government, and tribal communities.

4:00 – 4:30PM

Moderator: Bob Marvinney
Maine Department of Agriculture, Conservation and Forestry, Maine Geological Survey, Augusta, ME; robert.g.marvinney@maine.gov

** Approved for 0.5 TCH*

Panel Discussion

With participating agencies of the Maine Interagency Climate Adaptation Work Group (MICA):

- Nathan Robbins, Maine DEP Climate Program
- Sophia Scott, Maine CDC Drinking Water Program
- Amanda Shearin, Maine IFW Bureau of Resource Management
- Tim Spahr, Maine IFW Maine Warden Service
- Charles Hebson, MaineDOT Environmental Office
- Anne Fuchs, MEMA Hazard Mitigation
- Ryan Gordon, Maine Geological Survey

Poster Session

Juried High School, Undergraduate & Graduate Poster Session

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

Posters are on display throughout the day and can be viewed at any time. The scheduled poster viewing session, when presenters are requested to be available to answer questions, is during the morning break from 10:30 – 11:30AM.

Poster Overview

High School Posters

1. *Correlations Between Micro and Macroplastic Accumulation on Mount Desert Rock*
Andrea Grossmann, John Bapst Memorial High School

2. *The Effect of Animal Colonies on the Biodiversity of MDR Tide Pools*
Jennifer Noyes, John Bapst Memorial High School

3. *Microplastics Stink!: A Comparison of Microplastics Counts in Seal Scat Compared to Gull Scat*
Soleil Skehan, John Bapst Memorial High School

Undergraduate Posters

4. *Understanding Regional Differences in Citizen Concerns of Maine Aquaculture*
Nicholas D. Alvarez, University of Maine

5. *The Impact of Knowledge on Perceptions of Aquaculture in Coastal Maine Communities*
Erin Brown, University of Maine

6. *56 Surf Street: Sea Level Rise, Flood Risk, and Property Values*
Stephen Bull, Bates College Student

Poster Session - Overview

7. *Nutrient Content Analysis of Romaine Lettuce (Lactuca sativa var. longifolia) Grown in an Aquaponics System vs. Grown Conventionally*
Adeline Casali and Brooke Connelly, University of Southern Maine

8. *Acid or Eaten? Impacts on Soft-shell Clam Survival in Downeast Maine*
Krista Chandler, Hailey Wegner, University of Maine at Machias

9. *Microplastics in Sebago Lake Drainage Basin*
Shaylee Davis, Rebecca Regan, Dylan Fournier, Jarrett Beaulier, St. Joseph's College of Maine

10. *UNE is a Living Laboratory for Stormwater Management*
Paige Dugan, University of New England

11. *Past, Present, and Future of the College of the Atlantic Stream: A Small Coastal Watershed Assessment*
Patricio Gallardo García Freire, College of the Atlantic

12. *Working Towards Creating a Circular Nutrient System*
Skyler Horton, University of Maine

13. *The Effect of Providing Economic Information to Consumers Perspectives of Aquaculture*
Charles Jones, University of Maine

14. *Household Water Consumption: Drought and Revenue Instability*
Tala Kasih, Bates College

15. *Using Industry for Change: Cellulose-Based Food Packaging Products*
Shayla Rose Kleisinger, University of Maine

16. *The Role of Citizen Stewards in Monitoring the Health and Sustainability of Maine's Lakes*
Colleen Metcalf, University of Southern Maine

17. *Generation and Recovery of Hospital Food Waste in Maine*
Hannah Nadeau, University of Maine

18. *Bridging the Gap: Community-based Food Scrap Diversion*
Taylor Patterson, University of Maine

19. *Supporting Public Involvement in Dam Decision Making with Dam Factsheets*
Kaitlyn Raffier, University of Maine

20. *Quantifying Tidally Driven Transport in the Jordan River Estuary with Site Measurements and Analytical Model Evaluations*
Gwyneth Roberts, University of Maine

21. *Development of Environmental DNA tools for Sustainable Monitoring of Northeast Sea-Run Fishes*
Samantha Silverbrand, University of Maine

Graduate Posters

22. *Optimizing Strategies to Hydraulically Plant Atlantic Salmon Eggs Based on Fry Dispersal Patterns*
Ernie Atkinson, Maine Department of Marine Resources

23. *Exploring Public Perception and Preferences of Marine Coastal Issues*
Amy Bainbridge, University of Maine

24. *A Media Discourse Analysis of Right Whale Mortality Events in Maine*
Marina Cucuzza, University of Maine

Poster Session - Overview

25. *Understanding the Potential for Aquaculture Adoption Among Commercial Fishermen in Maine*
Caitlin Cleaver, University of Maine

26. *Is There a Demand for Aquaculture Insurance? An Analysis of New England's Oyster Market*
Avery Cole, University of Maine

27. *Zooplankton Phenology Variation Along an Elevational Gradient in Remote Maine Lakes*
Stephanie Dykema, University of Maine

28. *Environmental DNA for Sustainable Monitoring of Atlantic Salmon Occupancy and Abundance*
Brad Erdman, University of Maine

29. *Communication and Collaboration within the Atlantic Salmon Governance Structure of Maine*
Melissa Flye, University of Maine

30. *Assessing Invasive Mudpuppy Distribution in Maine Via Trapping and eDNA Efforts*
Vaughn Holmes, University of Maine

31. *Modeling Temperature, Dissolved Oxygen, and Phosphorus Concentrations in Lake Auburn, Maine*
Nicholas Messina, University of Maine

32. *Opportunity Costs and Biological Benefits of Streamside Management Zones in Forested Landscapes*
Eric Miller, University of Maine

33. *Innovative Resources for Small Ruminant Health*
Sarah Paluso, University of Maine

34. *Does Contamination Increase When Food Scrap Diversion is Required?*
Astha Thakali, University of Maine

35. *Thinking at the Margin: Examining the Role of Estuary Margin Watersheds in Coastal Bacteria Pollution Vulnerability*
Bea Van Dam, University of Maine

Professional Posters

36. *Conservation Science under Changing Conditions*
Sandra De Urioste-Stone et al., University of Maine

37. *Forecasting the Probability of Future Groundwater Levels Going Below Specified Low Thresholds*
Robert W. Dudley, U.S. Geological Survey

38. *Effects of Regulation and Urbanization on Historical Flood Trends in the United States*
Glenn A. Hodgkins, U.S. Geological Survey

39. *Combined and Stormwater Sewer Systems Influence Larvae and Adult Mosquito Abundance in Catch Basins, Bangor, ME, USA*
Alyssa Marini, University of Maine

40. *Monitoring the Impacts of Restoring Aquatic Organism Passage at Road/Stream Crossings*
Ben Matthews, The Nature Conservancy in Maine

41. *Recent Flume Facility Studies at the USGS-LSC Conte Anadromous Fish Research Laboratory*
Kevin Mulligan, U.S. Geological Survey

42. *Reducing Stream Acidification in Eastern Maine: Baseline Data*
Emily Zimmermann, Maine Department of Environmental Protection

Poster Session - High School

* Presenting authors are indicated in **bold**.

High School Poster Abstracts

Andrea Grossmann
John Bapst Memorial High School, Bangor, ME

1. Correlations Between Micro and Macroplastic Accumulation on Mount Desert Rock

This study aimed to compare and quantify macro and microplastics on a remote island off the coast of Maine, Mount Desert Rock. It also aimed to analyze the ways in which currents affect the distribution of plastics on the island. The hypothesis was that the places with the strongest current action would have the highest amount of plastics. There was also reason to support the hypothesis that places with the highest accumulation of macroplastics would correspond to places of highest microplastic accumulation due to macroplastics wearing down. Microplastic water samples were taken on the site, along with a survey of macroplastics on the site. The data was analyzed in aims to find the points of highest density and compare between the micro and macro plastic. Macroplastics were found at high amounts with much of the accumulation similar to that of the microplastics. This supports a hypothesis of macroplastics wearing down to form microplastics and a belief that currents dictate the distribution of marine debris on all levels.

Jennifer Noyes
John Bapst Memorial High School, Bangor, ME

2. The Effect of Animal Colonies on the Biodiversity of MDR Tide Pools

This study looked at the biodiversity found in the tide pools on Mount Desert Rock, an island home to colonies of gulls and seals. The biodiversity of the tidepools are an indicator of the health of the entire island and are affected by a multitude of things. The focus of this study was to find the most influential factors. The island was divided into four sections, each dominated by a different species. One quadrant was dominated by gulls, one by seals, one (the control) was not dominated by either, and the final one was the quadrant with pools of stagnant water. The study concluded that the nutrients that the animals on the island added to the tidepools had minimal effect on the biodiversity of individual tidepools studied. The main cause of varying biodiversity was the location of the tidepools in the intertidal zone. i.e. the pools farthest down with the most interaction with the tide had the most biodiversity. Having baseline counts of current biodiversity in tidepools in these ecosystems is becoming increasingly important. This baseline is needed as a reference point due to rising sea temperature as a way to track the overall effect of climate change on oceanic climates.

Soleil Skehan
John Bapst Memorial High School, Bangor, ME

3. Microplastics Stink!: A Comparison of Microplastics Counts in Seal Scat Compared to Gull Scat

Pollution in air and waterways has been contaminating our environment for decades, threatening the stability of ecosystems across the globe. An increasingly growing concern, however, has risen surrounding microplastics, specifically their presence in marine ecosystems. Not much research has been conducted concerning the effects of these particles on marine life, but we know their presence is affecting marine ecosystem organisms across the board. My research was conducted on Mount Desert Rock, a very small research island located 25 miles off the

coast of Maine. There is little vegetation on the island, most dry land being composed of rock. All scat samples were collected from August 6th to 12th of 2018, with mild temperatures and moderate precipitation levels throughout the week. Several months passed where samples were kept frozen until the sieving process began. After sieving through each sample, chemical analyses were used to digest all biological material. Enzyme digestion was the last chemical step, used instead of "oxidizing agents" to avoid degradation of the plastic particles. The final step is analyzing each sample under a microscope and recording counts of plastic particles in each sample. The primary purpose of this experiment is to compare plastic counts in gull scat to those in seal scat and final results will be presented at the conference. However, both squid beaks and fish otoliths were found in seal scat samples, giving insight into their diverse diet.

Undergraduate Poster Abstracts

Nicholas D. Alvarez (student), Caroline L. Noblet, Erin Brown (student)
School of Economics, University of Maine, Orono, ME

4. Understanding Regional Differences in Citizen Concerns of Maine Aquaculture

Maine, with its over 3,000 miles of coastline (NOAA, 2016), is poised to further develop its aquaculture industry. Already, aquaculture in Maine generates an estimated $137.6 million in sales and contributes over a thousand jobs with $56.1 million in labor income towards Maine's economy when multiplier effects are included (Cole et al., 2017). However, citizens voice concerns over current and future environmental impacts of its aquaculture industry. This study has uncovered important regional differences in various opinions relating to these concerns. Understanding the nature and characteristics of these regional differences may provide the key towards crafting and implementing effective political and environmental policy for aquaculture state-wide that can be favored by Maine citizens and viable to its industry.

Our study draws from survey data collected by the University of Maine (831 respondents; 15.6% response rate) that explored aspects of how Maine citizens view expansion and/or restriction of its aquaculture industry along its coastline. We investigated whether attitudes on aquaculture differ across populations within specific regions of Maine and its coastline in relationship to social-political factors. In this preliminary study, we find a statistically significant difference in citizen support for expansion of aquaculture depending upon where that industry is located in relation to where the citizens reside. We are currently investigating how such differences relate to their priorities for the Maine economy. These findings allow insight into how the aquaculture industry might improve the conveyance of information to Maine citizens thereby improving their opportunities for expansion.

Erin Brown (student), Caroline L. Noblet, Nicholas Alvarez (student)
School of Economics, University of Maine, Orono, ME

5. The Impact of Knowledge on Perceptions of Aquaculture in Coastal Maine Communities

At a time when global capture fishery production is stagnant, aquaculture remains the fastest growing food production sector (FAO, 2018). In Maine alone, the aquaculture industry generates approximately $73 million annually and has created over 500 jobs (Cole et al., 2017). Despite the growing importance of the aquaculture industry in Maine's economy, little is known about coastal Mainers' perceptions of aquaculture. The purpose of our study is to advance our understanding of coastal Mainers' knowledge of aquaculture in Maine and to investigate how their current knowledge levels impact their perceptions of aquaculture. To collect this data, a survey was sent to 4,000 households in coastal communities in Maine in Fall 2018, with a response rate of 11.7%. Participants reported a low

level of baseline knowledge and a desire to know more. On average, respondents reported a current knowledge level of 26.05, on a scale of 0-100, and a desired knowledge level of 58.73. Preliminary results suggest a strong relationship between reported knowledge of aquaculture and differing perceptions of the risks and benefits associated with it. Additionally, we find that those who reported a high level of knowledge are more likely to feel that aquaculture has positively impacted their use of Maine coastal areas than those who reported zero knowledge of aquaculture. This information can be used to aid decision-makers in addressing the concerns of stakeholders and in the creation of policy for this growing industry.

Stephen Bull (student), Lynne Lewis
Bates College, Lewiston, ME

6. 56 Surf Street: Sea Level Rise, Flood Risk, and Property Values

Using a hedonic property value model, I examine whether flood risk influences homebuyer's willingness to pay for housing. To this end, I estimate buyer's willingness to pay for a variety of housing attributes focusing on the willingness to pay to avoid owning a property in locations within FEMA Storm Surge Flood Zone predictions. Utilizing data from 3,420 unique real estate transactions within the towns of Saco, Biddeford, and Old Orchard Beach in York County, Maine, I consider the impact of new variables not found in other scholarly hedonic property value studies. These variables account for a variety of local real estate market characteristics such as overall housing supply and health of the real estate market. The inclusion of the new local real estate market characteristics for hedonic models produce mixed results, as each was evaluated individually based on its usefulness. Results of this research indicate that lack of complete information prevents these three town's real estate markets from fully capturing the risk associated with owning coastal property. Many houses in the towns of Saco, Biddeford, and Old Orchard Beach lie within potential flooding zones and sell in transactions that do not properly reflect the risk that buyers should associate with the houses. Suppliers of information such as Zillow or local town governments are falling short of close the gap between what sellers know and what buyers should be aware of.

Adeline Casali (student), **Brooke Connolly** (student), Emma Cost (student), Lily Wade (student)
Department of Environmental Science and Policy, University of Southern Maine, Portland, ME

7. Nutrient Content Analysis of Romaine Lettuce (*Lactuca sativa* var. *longifolia*) Grown in an Aquaponics System vs. Grown Conventionally

This experiment was conducted to research the differing nutrient contents of aquaponic and conventionally grown romaine lettuce, *Lactuca sativa* var. *longifolia*. We chose the topic of aquaponics due to its relevance in today's agricultural society. As adequate farming land and irrigation water sources become increasingly scarce, many farmers are turning towards unconventional agriculture such as aquaponics in order to conserve resources. Our hypothesis was that the aquaponically grown lettuce would contain higher nutrient contents than conventionally grown lettuce. Three beds were constructed; two aquaponics beds circulating with Oreochromis niloticus, Tilapia, and one conventional soil bed. After 5 weeks of growth, the heads were harvested, dried, and then measured for their nutrient content using X-ray fluorescence. The results showed significantly higher amounts of potassium, calcium, rubidium, and zinc in the aquaponics lettuce. Further research is recommended as to what contributed to the high zinc content in the aquaponics lettuce, as well as how results may differ in other leafy green vegetables.

Krista Chandler (student), **Hailey Wegner** (student), Brian Beal, William Otto
University of Maine at Machias, Machias, ME

8. Acid or Eaten? Impacts on Soft-Shell Clam Survival in Downeast Maine

Our work examines the relative importance of two aspects of climate change – coastal acidification and predation – on survival, growth, and recruitment of juveniles of the soft-shell clam, Mya arenaria. My arenaria is an iconic, commercially important marine bivalve that is the second or third most important marketable marine species harvested in the state of Maine. Landings, however, have declined by more than 50% over the past two decades. We are investigating the impacts of coastal acidification and predation as the causes of these declines in Downeast Maine. Through field experiments at two sites; Larrabee Cove, Machiasport and Duck Brook Cove, Cutler, effects of predation was measured through results of clam survival in open versus netted plant pots. The effects of acidification were examined through the results of clam survival in both the pots, as well as natural recruitment of clams in self-made recruitment boxes. The pH and total alkalinity were measured biweekly throughout the field experiment from June 12th – until removal of experimental units at both sites in the month of November. Saturation state (Ω) was calculated using CO2SYS. The saturation state varied over time throughout the study, suggesting an important time dependence between clam development/growth and spat timing and changes in the recorded saturation states.

Shaylee Davis (student), **Rebecca Regan** (student), **Dylan Fournier** (student), **Jarrett Beaulier** (student)
St Joseph's College of Maine, Standish, ME

9. Microplastics in Sebago Lake Drainage Basin

The purpose of this project is to explore and identify microplastics in freshwater systems. To learn more about this emerging concern, multiple groups of students collected water samples from the lower drainage basin of Sebago Lake. After filtering the samples, microplastics filaments and fragments were identified in all freshwater samples by microscopy and a "hot needle" test. No microplastics were found in a Portland tap water sample (Portland Water District treated Sebago Lake water). Although the risks of microplastics aren't well-established or commonly known, this project aims in spreading awareness of microplastic pollution and actions that may limit future pollution.

Paige Dugan
University of New England, Biddeford, ME

10. UNE is a Living Laboratory for Stormwater Management

In the Fall 2018, ENV375 "Sustaining Water- Global Perspective, Local Action" undergraduates explored global approaches to sustaining water on the University of New England campus in Biddeford. This class provides an understanding of practices for sustaining water around the world, and the effects of unsustainable practices on people. Students learned about practices used on campus that handle stormwater management. Students participated in a two-part capstone project that required them to create a learning tool easily understood by all people. Each student picked a stormwater best management practice (BMP) in place on the Biddeford campus. Students researched BMPs to determine how they affect the environment and prevent pollution. Students created a one pager that provided an awareness of thirteen BMPs. Research by the students provided information on how these methods worked and the importance of using them has on the environment. This poster illustrates the different methods and the role they play in protecting the Saco River. An overall result of this project was to give an in-depth awareness of the diverse systems used to manage stormwater by educating the public about our living laboratory on cam-

pus. Next steps include using the student proposals to build a website, stormwater trail and training opportunities for watershed managers and local students.

Patricio Gallardo García Freire (student)[1], Sarah R. Hall[1], Brian L. Henkel[2]
1 College of the Atlantic, Bar Harbor, ME
2 Friends of Acadia, Bar Harbor, ME

11. Past, Present, and Future of the College of the Atlantic Stream: A Small Coastal Watershed Assessment

In this study, we established a baseline characterization of the COA Stream (COAS) and its respective COA Watershed (COAW). The project was guided by four spheres of study: The Spatial, Social, Ecological, and Economic Spheres. We identified changes in land use, land ownership, and water infrastructure through time that may have led to the current configuration of stormwater outlets, drinking water mains, and sewage piping within the COAW. Using GIS, we created a database with relevant geological, hydrological, and ecological data for the COAW, to be expanded through future research questions. Given the substantial landscape changes associated with the recent reconstruction of Rt. 3 and the future construction of the Center for Human Ecology, a new building proposed for the COA campus, we established monitoring stations at all the freshwater outlets of the COAW draining to Frenchman Bay. With this study, we developed a framework for continued monitoring of some useful ecological metrics: discharge, stage, channel geometry, pebble counts, and water quality, which enable us to identify hourly, seasonal, and annual trends in watershed conditions. These data and corresponding infrastructure can inform best management strategies and provides an educational resource on the COA campus tied to course curricula, as well as opportunities for public involvement through Citizen Science. Beyond the larger stream networks within Acadia National Park (ANP), monitored by ANP and Wild Acadia initiatives, this current study serves as a model to expand monitoring, through a human ecological approach, to other coastal watersheds of Mount Desert Island beyond Acadia National Park that also drain into Frenchman Bay. Continuous monitoring of small coastal watersheds is important for identifying contributions of sediment, nutrient, and pollutant loads from similar watershed systems draining directly to the intertidal zone; these small drainage networks that line our extensive Maine coastline have direct impacts in the ecological, social, and economic integrities of coastal communities.

Skyler Horton (student)
University of Maine, Orono, ME

12. Working Towards Creating a Circular Nutrient System

Currently most food waste is either landfilled or incinerated; but it could be used to feed hungry people, or to cycle nutrients back into productive soils. While it is best to redistribute excess food to those in need, not all discarded food is edible, and transportation is a major barrier. Composting and anaerobic digestion provide an alternative to land filling and can recover nutrients from food waste for other agricultural purposes. But, these industries, if not managed sustainably, also have the potential to produce new risks. Contamination of feedstocks is one of the biggest problems facing operators; feedstocks come from a variety of businesses, meaning that the quality of the inputs is highly variable. The research presented aims to understand how nutrient cycling facilities perceive and respond to these risks. Understanding risk perceptions is key to creating a circular nutrient system, because these perceptions influence how facilities respond to potential risks, the safety of their product and ultimately, whether or not soil amendments are safe. A survey was developed and sent out to food processing facilities across the New England region to understand operators risk perceptions involved with their businesses and gain insight into how

the facilities operate. These risk perceptions are important to identify and address so that mitigation strategies can be developed, and operators can run a more sustainable business that contributes to waste reduction and more sustainable local food systems.

Charles Jones (student)
School of Economics, University of Maine, Orono, ME

13. The Effect of Providing Economic Information to Consumers Perspectives of Aquaculture

Despite its history in Maine and popularity in other parts of the world, aquaculture is still a growing industry with considerable potential in the United States. Expanding industries face many challenges, one of these is consumer perspective of said industry. Consumer sentiment and perspective can be a strong boon to an industry, or a hindrance (Kilkenny, Nalbarte, Besser). The perspective of aquaculture has largely been focused on environmental aspects and economic factors to a lesser extent. With the success of international fisheries, the economic prospects of aquaculture within the United States are growing. Informing consumers of this economic potential can provide the lift a developing industry needs to expand beyond its current limits and change citizen sentiment towards the industry. This is known as the framing effect, a well studied phenomenon of how changing the information provided to an individual or changing the way a choice is presented can affect their ultimate decisions (Kahneman, Tversky 1979). I want to examine how providing consumers with economic information regarding aquaculture affects their perspective of the industry. I will use data collected from a statewide survey conducted by the Economics Department of the University of Maine. The questions in this survey ask the respondent their opinions and experiences with aquaculture and its future in Maine. These surveys come in two forms, one providing aquaculture economic information to respondents, and another without. Preliminary results have shown a difference between the responses of both groups indicating the effect providing economic information can have on consumers.

Tala Kasih (student)
Bates College, Lewiston, ME

14. Household Water Consumption: Drought and Revenue Instability

Water scarcity has led water utilities and governments to implement conservation programs and restrictions to incentivize consumers to reduce water consumption. As a consequence of such restrictions, water utilities have struggled to maintain financial solvency or revenue stability, since a large portion of their costs are related to infrastructure (fixed costs). I utilize monthly water usage data, along with household characteristics data, from three different cities and neighborhoods in Los Angeles County to explore the effectiveness of switching from the current pricing mechanism used in Los Angeles county, increasing block-rate, to either a) consumption-based fixed rate; b) budget-based rates; or c) PeakSet base pricing model. I explore each price structure's ability to remain equitable and fair, incentivize users to reduce consumption, and provide the utility with stable revenue.

Shayla Rose Kleisinger (student)[1,2], Caitlin Howell[1], Balunkeswar Nayak[3]
1 Department of Chemical & Biomedical Engineering, University of Maine, Orono, ME
2 Senator George J. Mitchell Center for Sustainability Solutions, University of Maine, Orono, ME
3 School of Food & Agriculture, University of Maine, Orono, ME

15. Using Industry for Change: Cellulose-Based Food Packaging Products

Food waste management is a significant problem faced by the state of Maine, as most surplus food-products are incinerated or landfilled. A contributing factor to the large amounts of generated food-waste is the contamination and/or spoilage of food before it can be purchased and consumed. With pulp and paper having significant history and pre-established infrastructure in Maine, there is opportunity to utilize cellulose-based products as a new approach to addressing the shelf-life of food, along with creating new business avenues for an at-risk industry. This research highlights the use of cellulose nanofibrils (CNF), a wood-based product, as an alternative to non-biodegradable plastic food packaging. The incorporation of a physically-bonded layer of food-grade oil will allow for the creation of an anti-adhesive barrier that discourages bacterial growth, while remaining food-safe. The usage of food-grade/safe products gives potential for this material to be integrated into compost, therefore becoming a solution for the increase in non-biodegradable plastic products that are only partially re-integrated into the environment. This dual-layer material has the ability to decrease water adherence, which shows great promise in decreasing contaminant penetration. A lowered level of outside contaminants interacting with food products will lead to an increase in shelf-life and an overall reduction of food-waste. The Process Development Center (PDC) at the University of Maine is already capable of producing materials such as CNF; demonstrating that with the addition of equipment to pre-existing paper-mills, the issues of maintaining Maine industry and food-waste can simultaneously be addressed.

Colleen Metcalf (student)[1], Firooza Pavri[2]
1 University of Southern Maine, Portland, ME
2 Muskie School of Public Service, University of Southern Maine, Portland, ME

16. The Role of Citizen Stewards in Monitoring the Health and Sustainability of Maine's Lakes

Maine's freshwater lakes are a vital natural resource that provide economic, recreational and ecosystem services. Their sustainable management is of utmost importance to both the communities that surround them and the state that depends on them. In this study, we consider the role of citizen scientists and lake residents in gathering data on lake water quality and assess their stewardship activities vis-à-vis lake conservation. In collaboration with the Lake Stewards of Maine, an organization that has trained volunteers to gather water quality data for Maine lakes since 1971, we distributed surveys to learn more about the volunteers, the lake associations that they are involved with, and the factors that motivate them to engage year after year. Data from surveys gathered in 2015, 2016 and 2018 are presented here. The survey instrument collected demographic information as well as the types of activities conducted by lake association residents and citizen scientists and their rationale for engaging in this work. Open-ended questions provided in-depth data on stakeholder knowledge and use of Maine lakes, and insights about the environmental and stewardship issues related to lakes. The results collated from 398 total respondents indicate an overall deep personal attachment to the body of water they monitor, and concern over its health and quality. The results of this work allow us to evaluate the participation and engagement of local residents and citizen scientists in lake and conservation management. Insights from the study will enable us to comment on the factors that influence the long-term participation and involvement of the public in conservation activities.

Hannah Nadeau (student), Deborah Saber
Senator George J. Mitchell Center for Sustainable Solutions, University of Maine, Orono, ME

17. Generation and Recovery of Hospital Food Waste in Maine

This study explores the ways in which food waste is generated and disposed of in hospitals throughout the state of Maine. From single-use gowns and gloves to disposable medical equipment, hospitals are large producers of many types of waste. While there has been little research about hospital food waste, in Maine as much as 43% of the municipal waste stream is composed of organic material, including food waste, suggesting that hospitals also produce significant amounts of wasted food. Food waste in hospitals may come from food preparation, uneaten patient meals, and staff/visitor meals. This study addresses a critical knowledge gap, as in Maine there is little information on the topic of hospital food waste. We developed a survey to understand what hospitals in Maine do with their food waste and whether or not these practices promote the sustainable management of wasted food. Conducted at seven hospitals across the state, our survey creates a picture of food waste management practices and suggests further areas of research and intervention to promote sustainable food waste management practices. The data generated through this effort not only fills a gap in existing research, but suggests applied solutions to issues of food waste in Maine.

Taylor Patterson (student)
Ecology & Environmental Sciences and Senator George J. Mitchell Center for Sustainable Solutions, University of Maine, Orono, ME

18. Bridging the Gap: Community-Based Food Scrap Diversion

Food waste is a momentous issue in Maine, taking up more space in our household garbage than any other material. This waste will ultimately end up in a landfill or incinerator, where all of its nutrients will be lost. Composting can be used as an effective materials management practice, to recover nutrients and promote a more circular food system. Maine's rural geography is a barrier in implementing food-scrap diversion programs throughout the state. Community-based composting programs pose a potential solution to overcoming organic waste management challenges in rural areas. Community-based composting programs recognize the value in organics. By composting food waste locally, these programs benefit all members of a community by providing organic waste management, creating local jobs, conserving landfill space, and circulating capital throughout the local economy. The purpose of this research project is to bridge the gap between a community and food scrap diversion through a composting program, in this case working with a local dairy farm and an enthusiastic couple looking to establish food scrap diversion in their hometown. Through this collaboration, the program is able to provide services for households, businesses, schools, and municipalities in MidCoast Maine. The intent of this research project is to serve as an example for areas or individuals who are interested in diverting organics.

Kaitlyn Raffier (student), Sharon Klein, Emma Fox (student)
School of Economics, University of Maine, Orono, ME

19. Supporting Public Involvement in Dam Decision Making with Dam Factsheets

Involving the public on dam decision making is a necessary yet challenging feat. Many researchers, practitioners, and citizens alike emphasize the need for citizen support and engagement in dam decision making to ensure all voices are heard. When a hydropower dam project reaches relicensing for the Federal Energy Regulatory Commission (FERC) and stakeholders are given the opportunity to voice their opinion on what should happen to the dam,

dam information can be difficult to access. The information to determine what decision criteria people value is spread widely across many sources, which takes time and energy to access and understand; two things that stakeholders do not always have. My work addresses the issue of information access by compiling, organizing, and presenting data in a digestible way for stakeholders from a variety of backgrounds to understand, ultimately creating a series of Dam Factsheets that provide relevant data for dam decisions. I created seven factsheets covering the West Enfield, Medway, Milford, Ripogenus, Ellsworth, Lower Mousam, and Penobscot Mills Project. The Dam Factsheets are available on the Future of Dams blog and accessible to anyone. As one piece of a larger Dam Toolbox being created by the Future of Dams team, these Dam Factsheets are living documents that could be adapted to a variety of other projects anywhere you can find a dam!

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20. Quantifying Tidally Driven Transport in the Jordan River Estuary

The Jordan River in Trenton, Maine is host to commercial mussel harvesting activities. These local aquaculture operations are susceptible to point source pollution and freshwater runoff induced closures, which are inherently linked to the dynamics of the estuary. This study aims to characterize the circulation patterns in the Jordan River estuary on various temporal scales to identify the controls of material transport in this system. In order to achieve this goal, a combination of in-situ collected data and analytical modeling was used to understand water level variations and tidal current velocity patterns in the river and to improve understanding of the hydrodynamic conditions and their implications for water quality. The model is based on the horizontal Reynolds Averaged Navier-Stokes equations in the shallow water limit with scaling parameters defined from characteristics of the estuary. Preliminary results of data analysis indicate that ebb velocities are dominant in the intra-tidal dynamics, indicating that subtidal (transport) velocities will be prominent in this system. Model results for subtidal flows show that there is outflow over the shoals and inflow over the channel driven by a combination of advection and Stokes drift. This pattern indicates that pollutants introduced to the system near the banks (from land-based sources) will be advected out of the system while pollutants introduced in the center (or from the seaward boundary) will be advected into the system. Thus, land-based pollutants will spend less time within the estuary. These results can be used to inform management decisions to minimize closure time throughout the harvest season.

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21. Development of Environmental DNA Tools for Sustainable Monitoring of Northeast Sea-Run Fishes

Many sea-run fishes support important commercial and recreational fisheries, or are targets for extensive restoration efforts in the Northeastern United States. These resources require regular monitoring with emphasis on species distributions, phenology, and population dynamics if they are to be managed in a sustainable fashion. Historically, sampling techniques such as gill nets, electrofishing, and trap nets have been used to monitor diadromous species. These traditional methods are labor-intensive, require special training and permitting, are inefficient for

rare species, and can harm captured individuals. Recent advances in molecular biology suggest that environmental DNA (eDNA), genetic material naturally shed by organisms into their environment, can be detected in water samples to provide a less laborious, minimally stressful, and more sensitive alternative. Indeed, environmental DNA sample collection can be conducted by non-specialists, providing an opportunity to increase monitoring participations. However, taxon-specific eDNA assays need to be developed and vetted for many diadromous species. Here we provide results of an effort to develop and test species-specific environmental DNA markers for diadromous fish species in the Gulf of Maine. To date, we have successfully developed and tested eDNA assays for Atlantic salmon, brook trout, rainbow smelt, river herring, American shad, and sea lamprey. Additional research is being conducted to develop genetic markers for four additional diadromous species (shortnose sturgeon, Atlantic sturgeon, striped bass, American eel). Our goal is to make these assays interchangeable and combinable in the same sample reactions to permit co-detection. The development of these new eDNA assays will ultimately provide monitoring and restoration programs with a potentially powerful tool to complement or supplant current sampling methodologies.

Graduate Poster Abstracts

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22. Optimizing Strategies to Hydraulically Plant Atlantic Salmon Eggs Based on Fry Dispersal Patterns

The Gulf of Maine Distinct Population Segment of Atlantic salmon has suffered from habitat loss and exploitation over the last century. Hatchery supplementation has unquestionably prevented the extirpation of the species over the last decade. Stocking older life history stages minimizes early life history mortality, but does so at a cost of limiting exposure to a natural freshwater environment. Egg planting is a process by which fertilized eggs from the hatchery are injected into the gravel in the fall, replicating the natural spawning process in streams and provides a natural experience which can be important for adaptation. This methodology has been used experimentally within the region, but significant uncertainties exist in developing the effective implementation of this method at a greater scale. Specifically, the habitat dependent distribution of juveniles after emergence from the gravel would provide information necessary to apply the technique to meet conservation hatchery goals with respect to fall parr densities. We propose to characterize the dispersal pattern of egg planted Atlantic salmon as a function of habitat and use these data to construct a GIS based tool to inform stocking. This work, if successful, can help to optimize the application of egg planting at a management level.

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23. Exploring Public Perception and Preferences of Marine Coastal Issues

Understanding public awareness and concerns about marine coastal issues is vital to comprehending the complex relationship between people and the ocean and may help improve sustainable management of our coastal zone. Prior research shows that our relationship with the coastal and marine environment, as well as our knowledge, beliefs, trust in science and government, and educational status can all influence perception of how we see coastal and ocean issues. Our research explores this topic at a regional level, investigating coastal Maine marine perception

of coastal issues using survey data. Frequencies, cross tabulation, and logistic regression is utilized to 1) investigate perceptions of policy-relevant knowledge concerning ocean and coastal priority areas listed in the Maine Coastal Program; 2) determine what characteristics may be associated with higher levels of regional coastal and ocean awareness and preference; and 3) determine if perception of current ocean and coastal issues, as well as awareness of ocean policy, interaction with the coast, belief in climate change, and confidence in science plays a role in preference for marine planning and protection. Preliminary results show a clear relationship between an individual's perceptions of each of the ocean issues, and those corresponding preferences. On average, there exists a significant positive relationship between those that agree with coastal perceptions related to coastal hazards, ocean resources, wetlands, and impacts of development and their preference level for those coastal issues. Results from our research may assist state and local governments to better understand and advocate for regionally specific concerns.

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24. A Media Discourse Analysis of Right Whale Mortality Events in Maine

The North Atlantic right whale is one of the most critically endangered large whales in the world. In 2017, NOAA Fisheries declared an Unusual Mortality Event (UME) for the North Atlantic right whale population after a total of 17 deaths occurred in the U.S. and Canada, eliminating 3% of the population. To date, scientists, government officials, and the fishing industry have struggled to come to a consensus on the cause of the UME. This has contributed to high levels of uncertainty surrounding the mortalities and impeded preventative policy action to reduce further mortalities. In this exploratory study, we investigate the high level of uncertainty surrounding the cause of the UME by analyzing the portrayal of right whale mortality events in Maine newspapers. We report on the results of a qualitative content analysis of Maine news media during the right whale UME from April 2017 to September 2018. Understanding how the UME is being portrayed and by whom may provide avenues for considering potential barriers in the implementation of effective action in and between various actors such as regulators, scientists, and the fishing industry in both the U.S and Canada. Results from this exploratory study have important implications for local news coverage of complex human-natural systems issues in Maine and beyond. Furthermore, these results carry worthwhile contributions to the science communication and sustainability science fields; particularly, in terms of the efficacy of such methodological approaches in understanding environmental risks and issues of standing and influence.

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25. Understanding the Potential for Aquaculture Adoption Among Commercial Fishermen in Maine

Aquaculture is a growing industry in Maine and is viewed as a potential diversification strategy for commercial fishermen, as well as a way to sustain Maine's working waterfronts and coastal communities in the face of environmental change. The Aquaculture in Shared Waters program provides an opportunity for commercial fishermen to learn more about shellfish and seaweed aquaculture, while also providing an opportunity to understand the types of commercial fishermen who are considering the adoption of aquaculture. The program has run eight times in multiple towns since 2018. We will report results from pre- and post-course structured surveys completed by training program participants with a focus on motivations for considering the adoption of aquaculture, potential barriers to adoption and a description of the demographics and fishing experience of these individuals. Most

participants report looking to aquaculture a diversification strategy and are most concerned about learning all aspects of running an aquaculture operation. They report lower levels of concern about environmental uncertainty, the regulatory process, and managing community relations.

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26. Is There a Demand for Aquaculture Insurance? An Analysis of New England's Oyster Market

Aquaculture growers in New England have identified a number of critical impediments to future development of the industry. First and foremost, they identify the risks associated with aquatic crop loss as a burden on existing businesses but also a significant barrier to market entry. One risk mitigation strategy is the introduction of a crop insurance program. In this paper, we consider the plausibility of a regional crop insurance program by examining the willingness-to-pay (WTP) across oyster growers in New England.

We draw from a body of literature in agricultural economics to inform our model. Crop insurance programs are considered an important risk mitigation strategy in agriculture industries and despite espoused grower interest, crop insurance remains unavailable to aquaculture growers. We consider data collected in 2017 survey of aquaculture growers in New England. Using a conjoint analysis, we estimate a WTP for an insurance program that would cover one or several risk factors including storms, disease, both, or all production risks in the event of catastrophic losses. We utilize a generalized multinomial logit model to analyze our survey results. Results suggest that for both storm and disease insurance, grower WTP is approximately four percent of their annual revenue. There is an additional WTP of two percent of annual revenue to cover all other production risks. Preliminary calculations assessing WTP versus the costs of implementing a program indicate that a regional insurance program could operate on an actuarially sound basis.

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27. Zooplankton Phenology Variation Along an Elevational Gradient in Remote Maine Lakes

As the Earth's climate warms, scientists are increasingly focused on understanding ecosystem response to environmental changes. Significant climate-driven shifts have already been detected in northeastern lakes, including changes in the timing of seasonal events such as ice breakup. The organisms that inhabit a lake are susceptible to these shifts, however we have much more to learn about how different biological communities in lakes react to changes in the physical environment. This research aims to understand how zooplankton communities, in lakes across a range of elevation and climate zones, respond to lake phenology. As these small organisms react quickly to change due to their short life cycles, variation within zooplankton communities may indicate larger ecosystem shifts because of their position at the bottom of the food chain. Zooplankton will be collected in 14 remote Maine lakes along an elevational gradient in order to capture variation in climate and seasons, and lakes will be sampled in each season corresponding with ecologically important events such as ice-out and onset of thermal stratification. Zooplankton phenology will be compared among seasons and among lakes to understand which physical factors influence the phenology of different species. Zooplankton taxonomic groups respond differently to seasonal changes depending on their life-history traits and we will identify how these responses vary across the extremes of

climate conditions present in Maine. Disentangling the drivers of zooplankton phenology will provide a basis for understanding consequences of climate change for northeastern lentic food-webs.

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28. Environmental DNA for Sustainable Monitoring of Atlantic Salmon Occupancy and Abundance

Managing freshwater ecosystems often requires that we understand the distribution and abundance of species on the landscape. However, this core monitoring need is often highly constrained and costly for endangered species like anadromous Atlantic salmon (Salmo salar). Traditional population monitoring relies on labor intensive capture, requires special permits, and thus can only be conducted by relatively few specially-trained personnel. Environmental DNA (eDNA) testing of stream water provides a promising alternative to survey aquatic species in a more cost-effective, less invasive, and potentially more sensitive way. We provide results of two pilot studies that assess detection limits of salmon eDNA with a caged-fish study and compare eDNA detection rates and relative abundance estimates of Atlantic salmon parr from backpack electrofishing. Caged fish trials supported the ability of eDNA to detect small numbers of salmon at distances up to a kilometer and documented a relationship between fish abundance and eDNA levels. Likewise, both backpack electrofishing and eDNA analysis detected Atlantic salmon at 85% of survey sites. Site-specific detections were largely consistent across methods with positive detections using both methods at 21 sites, electrofishing-only detections at two sites, and eDNA-only detections at two sites. Interestingly, we did not detect a significant relationship between local eDNA concentrations and salmon relative abundance from electrofishing, which we hypothesize is due to eDNA transport. Further models that account for eDNA transport are currently being developed and may shed light on the hydrological dynamics of eDNA in lotic systems and improve the accuracy of eDNA relative abundance estimates.

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29. Communication and Collaboration within the Atlantic Salmon Governance Structure of Maine

The Atlantic salmon population in Maine remains critically low despite extensive hatchery supplementation and habitat improvement efforts. In 2000, the Gulf of Maine Distinct Population Segment was listed as an endangered species with joint listing authority shared by the National Oceanic and Atmospheric Administration and the United States Fish and Wildlife Service. Because, regulators and managers from Federal, State, and Penobscot Nation contexts operate with independent authority, recovery decisions depend upon effective communication and coordination. Using a mixed-methods approach we surveyed and interviewed members of the Atlantic Salmon Recovery Framework (ASRF), the governance structure responsible for Atlantic salmon management and recovery in Maine. The communication network analysis utilized survey results to better understand the flow of information and communication between members of ASRF and found that there is a relatively high network density for individual communication, but that these communications are poorly centralized and may be more compatible with

some organizational structures than others. Communicative relationships formed distinct communities falling generally along organizational boundaries, indicating that individual communicative relationships are reflective of organizational affiliation rather than framework structure. Challenges reported by members fit generally into three categories: membership confusion; mismatches between framework and organizational structures; and poorly defined responsibilities. Despite these challenges, participants reported a commitment to maintaining a collaborative governance structure. Individuals reported long-standing relationships and a history of working together within and between organizations. This coupled with the high degree of communication, shows that communication pathways exist and may be built upon moving forward.

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30. Assessing Invasive Mudpuppy (*Necturus Maculosus*) Distribution in Maine Via Trapping and eDNA Efforts

First introduced in Maine 1939, the common mudpuppy (*Necturus maculosus*) is an invasive, fully-aquatic salamander. Since introduction, there have been many anecdotal reports of mudpuppy captures in lakes in central Maine, but no efforts to assess distribution, population sizes, or impacts on aquatic ecosystem sustainability. It is possible that mudpuppies feed on certain lacustrine species of state conservation concern (e.g. Ephemeroptera, Odonata, Gastropoda), or compete with native fish in the area. This develops survey approaches to assess the extent of mudpuppy invasion in Maine. The combination of being fully aquatic and potentially rare in new colonization sites, presents challenges for traditional survey methodologies. As such, this project paired traditional transect trapping efforts by the Maine Department of Inland Fisheries and Wildlife with new environmental DNA (eDNA) sampling methods developed by the University of Maine. Environmental DNA sampling detects the DNA that organisms naturally shed in the aquatic environment, and is thus sensitive to detecting an organism even when it is not immediately present at a sampling site. Both trapping and eDNA approaches have confirmed that mudpuppy have spread widely from their initial introduction site. Our initial data indicate that eDNA sampling has detected the presence of mudpuppies in more waterbodies than trapping methods, indicating that eDNA monitoring may be a more sensitive means to monitor this elusive invader. We are currently refining our eDNA sampling approaches and conducting follow-up eDNA and trapping surveys to further confirm mudpuppy distribution and assess whether eDNA can also provide insight into relative mudpuppy abundances.

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31. Modeling Temperature, Dissolved Oxygen, and Phosphorus Concentrations in Lake Auburn, Maine

Lake Auburn, Maine is a historically unproductive lake that has experienced multiple algal blooms over the last decade. The lake is the water supply source for a population of ~60,000. In 2011, the lake experienced longer than usual hypolimnetic anoxia that led to internal phosphorus release and an excessive algal bloom; Hurricane Irene preceded the bloom. The 2018 algal blooms were preceded by intense storms that transported phosphorus to the lake from the tributary streams, but no extreme hypolimnetic anoxia. The goal of this study is to model phosphorus concentrations in Lake Auburn by considering the watershed and internal contributions, and to predict the

likelihood of algal blooms. A system of linked models containing a stream hydrology and phosphorus loading model and a lake model for simulating physical mixing, biological dynamics, and sediment geochemistry was used to simulate phosphorus concentrations in Lake Auburn from 2011-2018. Stream flow and total phosphorus loads were modeled in the two major tributaries, Townsend Brook and Basin Brook, using the computer program SimplyP. Temperature and dissolved oxygen profiles were modeled using the computer program MyLake and calibrated using the MATLAB Genetic Algorithm. Our results show that simulation of lake temperature, dissolved oxygen, and phosphorus proves an effective means for predicting the loss of water quality under changing land use and climate scenarios.

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32. Opportunity Costs and Biological Benefits of Streamside Management Zones in Forested Landscapes

One of the most pervasive conservation challenges is balancing land resource utilization and habitat quality. Maintaining streamside management zones (SMZs), otherwise known as riparian buffers, can enhance stream and river restoration. Despite near consensus about the potential of this management tool, numerous questions remain about the use of such zones in practice, especially in forested landscapes. Using experimental data collected from 14 sites in Northwestern Maine, this research advances simulations that contrast the economic value of harvesting timber in riparian areas with the biological benefits resulting from SMZs. We focus on how the width of SMZs influences this contrast. The opportunity cost is dependent on the merchantable species present, as well as the width of SMZ, which is reflected in our results. Overall, the presence of SMZs improves stream biological health, but the insect species responses vary across buffer zone widths and the biodiversity benefits diminish eventually as SMZ widens. Forest managers of Maine can use these results to guide their timber harvesting policy, as well as providing landowners with insights as to how to protect streams while utilizing their forest lands. Our analysis is relevant for crafting ecological policies and provides insight to incentivizing conservation practices for landowners.

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33. Innovative Resources for Small Ruminant Health

Caseous lymphadenitis (CL) is a chronic disease of sheep and goats caused by the pathogenic bacterium, *Corynebacterium pseudotuberculosis* (Cp). The disease is characterized by the formation of "caseous" abscesses, which cause significant decreases in wool, meat, and milk production of these animals, costing the worldwide industry millions of dollars each year. Once shed via ruptured abscesses, Cp remains infective in the environment for long periods of time, where it can quickly spread to the rest of the herd. Antibiotics have had limited success in treating CL, due to the difficulty of penetrating the dry, thick-walled abscesses. The purpose of this project is to find an alternative method of treatment and control of CL using components of essential oils with known antimicrobial properties. Essential oils are complex bioactive compounds that have been increasingly explored as sources of antimicrobial activity as the Food and Drug Administration currently discourages use of medically-important antibiotics in food animals (VFD; www.fda.gov). The minimum inhibitory concentrations of nine essential oil components were tested using a standard disk diffusion assay. Five of these components (thymol, carvacrol, trans-cinnamaldehyde, cuminaldehyde, and B-citronellol), successfully inhibited the growth of Cp in vitro and will be tested for cytotoxicity to mammalian cells. Due to the nature of essential oils, tissue penetration may be possible, and environmental treatment (as disinfectants of farm surfaces, such as feeders or shearing equipment) may be eas-

ily done. By maintaining healthy flocks and eliminating the need for toxic disinfection methods, this project could have a positive impact on sustainable agriculture.

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34. Does Contamination Increase When Food Scrap Diversion is Required?

A more sustainable food system model is needed to prevent food waste, address food insecurity, and ensure nutrients are recycled back into the soil. A sustainable food system would return nutrients from waste to agricultural soil to produce more food. But there is a possibility of unforeseen, unregulated and emergent risks arising from a mixed waste stream. Contaminants may enter the food supply chain at various points from pesticides applied during production to contamination from packaging materials to poor separation from non-food wastes in homes and institutions. The fate of some biological contaminants is unknown. The purpose of this study is to determine if there is greater risk associated with mandatory separation of food scraps versus voluntary participation. The goal is to identify the emergent risks associated with more cyclical food systems and to identify appropriate management procedures, policies and programs to reduce risks. Food waste was collected from three states (MA, ME and VT) from five sources during summer of 2018. Food scraps were processed to a uniform consistency using a food processor and tested for heavy metals, halogenated organics (EOX), pathogens and antibiotic resistance genes (ARGs). Samples from regulated states were more contaminated than the ones from non-regulated state in terms of plastic contamination. None of the samples exceeded any heavy metals contaminants regulatory limits. EOX was also within safe limits. We are working on determining ARGs and pathogens in our sample. Until now, it looks food scrap diversion is better in non-regulated state and food waste is safe to recycle.

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35. Thinking at the Margin: Examining the Role of Estuary Margin Watersheds in Coastal Bacteria Pollution Vulnerability

Bacteria pollution closures of Maine's coastal shellfish harvest areas have substantial economic and social consequences for more than 1500 licensed harvesters and their communities. To sustainably manage shellfish harvest areas and avoid unnecessary closures, the Maine Department of Marine Resources (DMR) requires coastal data to make science-based decisions. Recent research of land-sea connections in Maine demonstrates correlations between coastal landscape conditions and estuary bacteria levels near non-tidal watershed outlets, providing a proof-of-concept for the use of cluster analyses to group non-tidal watersheds into a limited set of similarly-behaving coastal settings. However, the analysis omitted many near-coast landscape areas bordering the estuaries that did not fall within the 535 non-tidal watersheds used as the domain for clustering, leaving an important data gap.

This poster describes the ongoing work to incorporate the omitted "margin" watershed areas into an upgraded cluster analysis that seeks to assess the vulnerability of varied coupled landscape-estuary settings along Maine's coast to bacterial pollution. Surface water flow direction delineation within "margin" watershed areas has produced the most complete set of high-resolution flow path data for the Maine coast and from these data the contributing areas to the state's coastal estuaries and embayments are being delineated. The cluster analysis will incorporate an ex-

panded set of proxy metrics describing the sources, delivery, and estuarine residence time of bacterial pollutants in surface water runoff that cause problematic levels in shellfish harvest areas and provide DMR with improved decision support tools.

Professional Poster Abstracts

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36. Conservation Science under Changing Conditions

Global and local changes in environmental, social, and climatic conditions increasingly stress, alter, or degrade ecosystems and human quality of life despite continued efforts to develop integrated natural and human models that help support effective decision-making. In response, many organizations focus on managing for resilient human-natural systems—those that are able to respond and adapt to the effects of rapid change. Our recently awarded National Science Foundation Research Traineeship grant will create a new graduate education model that integrates faculty and students from the social and biophysical sciences in order to prepare the next generation of conservation leaders to address these challenges presented by a rapidly changing world. The University of Maine's NSF-NRT program will train the next generation of conservation leaders by (1) integrating biophysical and socioeconomic sciences into coursework; (2) fostering collaborative, engaged, transdisciplinary, and solutions-driven research; (3) offering professional development opportunities. Transdisciplinary research and active learning experiences central to the program will address governance frameworks, biodiversity conservation, sustainable rural livelihoods and resource dependent economies, stewardship values, citizen science and participation, and spatial sciences. Our goal is to build a well-trained and experienced workforce to advance conservation solutions that will ultimately lead to enhanced resilience of socio-ecological systems in Maine and beyond.

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37. Forecasting the Probability of Future Groundwater Levels Going Below Specified Low Thresholds

We present a logistic regression approach for forecasting the probability of future groundwater levels declining, or maintaining below specific groundwater-level thresholds. We tested our approach on 102 groundwater wells in different climatic regions and aquifers of the United States that are part of the U.S. Geological Survey Groundwater Climate Response Network. We evaluated the importance of current groundwater levels, precipitation, streamflow, seasonal variability, Palmer Drought Severity Index, and atmosphere/ocean indices for developing the logistic regression equations. Several diagnostics of model fit were used to evaluate the regression equations, including testing of autocorrelation of residuals, goodness-of-fit metrics, and bootstrap validation testing. The probabilistic predictions were most successful at wells with high persistence (low month-to-month variability) in their groundwater records and at wells where the groundwater level remained below the defined low threshold for sustained periods (generally three months or longer). The model fit was weakest at wells with strong seasonal variability in levels and with shorter duration low-threshold events. We identified challenges in deriving probabilistic-forecasting models and possible approaches for addressing those challenges.

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38. Effects of Regulation and Urbanization on Historical Flood Trends in the United States

Many studies have analyzed historical trends in annual peak flows in the United States because of the importance of flooding to bridges and other structures, and the concern that human actions may increase flooding. To help attribute causes of historical peak-flow changes, it is important to separate basins by characteristics that have different effects on peak flows, however, limited work has been published in this area. We analyzed historical trends by basin type: minimally altered basins, regulated basins (substantial reservoir storage but low urbanization), and urbanized basins (with low reservoir storage). We computed trend significance with methods that consider the possibility of short- and long-term persistence in the time-series data. Although many peak-flow magnitude trends were found in the last century across the conterminous United States, trend magnitude and direction vary by region and basin type. There was a low percentage of significant increases and decreases for minimally altered basins (2-14%, depending on time period and assuming time-series independence), while regulated basins had many significant decreases (24-56%), and the limited number of urbanized basins with long-term records had many significant increases (28-38%). Parts of the Northeast quadrant of the U.S. had high densities of basins with large (>50%) increases, including some urbanized basins. Parts of the Southwest quadrant had high densities of basins with large decreases, including many regulated basins. It is important to consider basin-specific features such as historical reservoir additions and urbanization when computing future design floods for bridges and other hydraulic infrastructure.

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39. Combined and Stormwater Sewer Systems Influence Larvae and Adult Mosquito Abundance in Catch Basins, Bangor, ME, USA

*Culex pipien*s and *Culex restuans* (Diptera: Culicidae) are two mosquito disease vectors that transmit West Nile virus in urban areas in the eastern U.S. These mosquitoes breed in a variety of natural and artificial habitats, including roadside catch basins, which are underground reservoirs designed to reduce the likelihood of flooding by collecting and conducting surface runoff through the subterranean storm drain system. In most urbanized areas of the U.S., older "combined sewer" systems (that accept stormwater, sewage, and industrial waste water) are being replaced by "separate sewer" systems (that separate stormwater and sewage). While it is well-established that urbanization has altered mosquito-borne disease dynamics via multiple ecological pathways, no research has addressed the effects of stormwater versus combined sewer systems on mosquito production. Therefore, our study investigated whether there is a difference in abundance of larval and adult mosquitoes in these two types of sewer systems. From May 30 to August 27, we sampled 20 catch basins in residential neighborhoods in Bangor, Maine (10 in combined sewer systems and 10 in stormwater sewer systems). We found that there is an increase in larval abundance in combined catch basins compared to stormwater catch basins, but the opposite holds true for the adult mosquito abundance, where there is an increase in abundance in the stormwater versus the combined sewers. Future studies will seek to identify ecological mechanisms that explain these patterns. Our findings are relevant to understanding the potential human health impacts of stormwater management practices via production of disease vector mosquitoes.

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40. Monitoring the Impacts of Restoring Aquatic Organism Passage at Road/Stream Crossings

Upgrading problem road/stream crossings is an effective method to restore fish passage and reduce flood risk, but the lack of evidence of these benefits can be a stumbling block for the engineers and planners that need to be convinced of the value these projects. The Maine Field Office's efforts to restore access to critical aquatic habitats provides a unique opportunity to investigate the efficacy of these aquatic organism passage (A.O.P) culvert replacement projects by monitoring the geomorphological changes resulting from our restoration efforts. Conducting pre/post construction surveys on culvert replacements allows us to quantify the impact of our restoration efforts and test the efficacy of A.O.P protocols. Tracking the resultant changes to stream morphology, sedimentation, substrate size class distribution and bed form allows us to directly compare our proposed design to the as-built project, giving stakeholders concrete evidence to quantify the success or failure of these projects. Further analysis of these metrics provides indirect measures of velocity, depth and flow that can be useful in quantifying both flood risk reduction and aquatic habitat connectivity. We will present a detailed look at the methodology and showcase some preliminary results from our first year of monitoring that highlight the benefits and limitations inherent in this method.

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41. Recent Flume Facility Studies at the USGS-LSC Conte Anadromous Fish Research Laboratory

This poster presentation will highlight two recent studies in the flume facility at the United States Geological Survey (USGS) Leetown Science Center S.O. Conte Anadromous Fish Research Laboratory. The first study, beginning in 2016, evaluated the effects of fishway entrance design and flow conditions on the entry and passage of adult American shad. Submergence depth, i.e. the difference in elevation between the tailwater and the entrance gate crest, was the main driver in passage time, followed by river temperature and gate design. The second study, beginning in 2018, evaluated the effects of a standard low-flow USGS gauging weir, commonly found at USGS streamflow gauges across the country, on passage of American shad. Passage rates were shown to increase as the water surface drop across the weir was lowered. The results of these two studies provide fish passage guidance criteria to numerous state and federal resource agencies that will aid in the management of both main-stem hydropower dams and low-head barriers.

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42. Reducing Stream Acidification in Eastern Maine: Baseline Data

Despite restored access, Atlantic salmon (Salmo salar) populations in eastern Maine remain low. Loss of fish populations due to surface water acidification in the North Atlantic region has been well documented. Most waters in eastern Maine periodically experience acidic conditions (pH <6.5), resulting in detrimental impacts to salmon, especially during snow melt and spring/fall runoff. Liming acidic waters (using agricultural lime) has increased salmon abundance in Scandinavia and Nova Scotia, and has been recommended as a restoration action for Maine.

A 2009 Project SHARE pilot study investigating the efficacy of using clam shells to lime streams suggested a positive trend. In collaboration with the Downeast Salmon Federation, a multi-year project will be conducted in the East Machias River watershed to further investigate the efficacy of this mitigation method, with the goal to increase macroinvertebrate abundance and diversity, and to increase juvenile salmon abundance. The first two years of the project characterized baseline conditions by monitoring water quality May-November using continuous monitoring devices and grab samples. Preliminary data analysis indicates periodic stressful conditions for juvenile salmon, including low pH (minimum of 4.19), high temperature (maximum of 28.46°C), low dissolved oxygen (minimum of 0.06 mg/L), low calcium (minimum of 0.80 mg/L), and high exchangeable aluminum (maximum of 53 ug/L). Dry summers resulted in extremely low stream flows, likely causing further stress to salmon in addition to affecting water quality. Monitoring efforts will continue for at least five years to determine the efficacy of using clam shells to mitigate acidity.

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