12TH BoFEP BAY OF FUNDY SCIENCE WORKSHOP
Truro, Nova Scotia, 9–12 May 2018

Abstracts are listed in order of presentation within each session; presenting author is highlighted

KEYNOTE SPEAKERS

An Uncertain Future: The Right Whales' Fight against Environment, Biology and Ocean Urbanization

Kimberley T. A. **Davies**
Department of Oceanography, Dalhousie University, Halifax, NS (kim.davies@dal.ca)

North Atlantic right whales (*Eubalaena glacialis*) are iconic Bay of Fundy animals that have become globally recognized as a poster child for the impacts of human activities on coastal environments. Their relatively unique life history makes them extremely susceptible to harm from certain human activities such as fishing gear entanglements and ship strikes, apparently more so that other large whales. Such harm then feeds back to impact the species' biology through a variety of lethal and sublethal effects. This talk examines the biological adaptations that put these animals at high risk, ranging from their feeding ecology to their reproductive cycles. This provides the context for discussing how changes in the Bay of Fundy environment and beyond have put the future of these animals in peril through impacting their population biology and risk from human activities. Looking to the future, unprecedented collaborative efforts are underway in Atlantic Canada that hope to improve the outlook for this species.

Drowning in Debris: Solutions for a Global Pervasive Marine Pollution Problem

Tony R. **Walker**
School for Resource and Environmental Studies, Dalhousie University, Halifax, NS (trwalker@dal.ca)

Global marine debris has been a growing concern for decades and is one of the most widespread sources of pollution facing the world's oceans from the remote Arctic to the Antarctic. The most abundant and widespread source of marine debris is plastics. An estimated 4.8–12.7 million metric tonnes of plastics entered the oceans globally in 2010. Plastic pollution in the oceans are comprised of microplastics (<5 mm diameter) a term first coined by Thompson et al. (2004) and macroplastics (>5 mm). Microplastics comprise: primary microplastics (microbeads), and secondary microplastics, from degraded macroplastics (plastic bags). Growing efforts have been made to monitor impacts of microplastics in the marine environment. Recent studies suggest that risks of microplastics (including degraded macroplastics, microbeads and microplastic fibres) in the marine environment may pose more of a threat than macroplastics. Marine debris therefore poses a serious threat to our environment, economy, navigation and now recognized as a potential threat to human health. Yet marine debris is preventable. Seven years ago, the Fifth International Marine Debris Conference (5IMDC) was held in Honolulu, Hawaii in cooperation with NOAA, the United Nations Environment Programme, and other agencies and organizations. The conference brought over 450 participants from the marine debris community together to develop and create a document known as the *Honolulu Strategy*. The *Honolulu Strategy* is a framework for a comprehensive and global effort to help reduce the ecological, human health, and economic impacts of marine debris. It was designed as a planning tool, common frame of reference for collaboration, and a monitoring tool for society, government, intergovernmental organizations, and the private sector. Since that conference advances in government policies to curb the use of single-use plastics have helped increase public awareness of this pervasive issue. The Sixth IMDC was held in San Diego, California in

March 2018. The 6IMDC brought together international marine debris researchers, natural resource managers, policy makers, industry representatives, and the nongovernmental community from around the world to participate to help transfer knowledge and expertise with more than 600 other marine debris stakeholders. Outcomes from this international marine debris conference included the pressing need to address and reduce the impacts of marine debris to vital natural resources, human health and safety, and the economy. This talk will share lessons learned and best practices to reduce and prevent marine debris and its impacts; promoting international co-learning; exchanging innovative ideas such as market incentives and communication strategies; and sharing latest research initiatives, methods, and results. To address the global marine debris problem, we need action and change-oriented solutions.

Reflections on the Bay of Fundy and its Future

Graham R. **Daborn**
Acadia Centre for Estuarine Research / Acadia Tidal Energy Institute, Acadia University, Wolfville, NS (graham.daborn@acadiau.ca)

More than a century of research has taught us a good deal about the Bay of Fundy, its resources and its critical biophysical processes. Much of this knowledge arose as a result of tidal power proposals, which intermittently stimulated broad-scale, interdisciplinary and collaborative research projects. Those studies taught us how biologically productive the Bay is, how tightly the different regions of the Bay are linked, and how extensive are the connections between the Bay and the rest of the globe. We have also learned that the Bay is constantly changing as a result of both natural and anthropogenic causes. Natural causes include: the post-glacial evolution of the Bay's morphology; long-term tidal rhythms; the continuing increase in tidal ranges; and changes in sea level. Human-caused changes have also been numerous, especially over the last 400 years: conversion of salt marshes, harbour and coastline development, resource exploitation (e.g., fisheries), and energy extraction. On top of all of this is the prospect of global warming, and biological indicators that seem to be related are coming in all the time. In order to manage the Bay into the future we need to review the state of our present understanding, identify what knowledge is still lacking, conduct well-coordinated, integrated research to fill in the gaps, and create well-founded models that will help us predict future states of this extraordinary system.

PANEL SESSIONS

Ocean Literacy and Awareness

Chair: Michael J.A. Butler
International Ocean Institute-Canada, Halifax, NS (michael.butler@dal.ca)

Panelists:

- Tracey Dean (Huntsman Marine Science Center)
- Roland Chiasson (Aster Group)
- Magali Grégoire (Canadian Network for Ocean Education)
- Kerri McPherson (C.P. Allen High School)
- Anna Naylor (Centre for Ocean Ventures and Entrepreneurship)

At a meeting of the BoFEP Steering Committee in 2017, a Working Group on Ocean Literacy and Awareness was established. The objective of the Working Group was to identify ways to improve the

public's understanding, particularly within the communities surrounding the Bay of Fundy, of the vital importance of the ocean and coasts to their wellbeing, from both an environmental and economic perspective. The escalating impact of climate change and other human induced stressors, such as pollution, have increased the importance of this task. We believe that the provincial education systems are one of the more important conduits to address this problem. The acknowledged abundance of ocean related expertise in Atlantic Canada, so rightly proclaimed in the likes of the Ivany Report, provides a unique opportunity and a resource from which to seek guidance and assistance. The panellists will provide examples of current initiatives and present their personal perspectives on addressing the challenge of enhancing ocean literacy and awareness within the educational system and in public fora.

Information Use at the Science-Policy Interface in Decision-Making in the Bay of Fundy Region

Panel Organizer: Environmental Information: Use and Influence (EIUI) research program, School of Information Management, Dalhousie University

- Bertrum MacDonald (Chair) - *School of Information Management, Faculty of Management, Dalhousie University, Halifax, NS (bertrum.macdonald@dal.ca)*
- Suzuette Soomai - *School of Information Management, Faculty of Management, Dalhousie University, Halifax, NS (suzuette.soomai@dal.ca)*
- Rachael Cadman – *School for Resource and Environmental Studies, Dalhousie University, Halifax, NS (r.cadman@dal.ca)*
- Simon Ryder-Burbidge – *Marine Affairs Program, Dalhousie University, Halifax, NS (s.ryder-burbidge@dal.ca)*
- Diana Castillo - *School of Information Management, Dalhousie University, Halifax, NS (diana.castillo@dal.ca)*
- Kalene Eck - *Marine Affairs Program, Dalhousie University, Halifax, NS (kalene.eck@dal.ca)*
- James Ross - *Faculty of Engineering, Dalhousie University, Halifax, NS (rossjd@dal.ca)*

The world's oceans are increasingly threatened by pressures related to human activities along coastlines, including, living and non-living resource extraction and climate change, amongst other pressures. In Atlantic Canada, the Bay of Fundy region supports a rich biodiversity, including many species at risk (whales and sea birds) and non-living resources. The region is a major hub for shipping, mining, and tidal power activities. Many of the industrial and natural activities compete with each other, making coastal and ocean management in the area very challenging. The Bay of Fundy is also a data and information rich area, with many data banks and thousands of publications produced over the last century. Regional policy and decision-makers need relevant information to consider options, make informed decisions, and take action to manage the many resource and environmental issues resources and risks effectively. How are these decision-makers accessing relevant information, and furthermore, how do they know what is the "right" information, given the large volumes of available data?

The Environmental Information: Use and Influence (EIUI) research program, School of Information Management, Dalhousie University has been examining the diffusion, use, and influence of information produced by governmental and non-governmental organizations responsible for giving strategic advice on current issues affecting the ocean. This research team has utilized a suite of methodologies (e.g., citation analysis, content analysis, and surveys and interviews of key informants) to measure information influence in the environmental management realm.

This panel, hosted by the EIUI research program, will describe the common challenges to information use in policy-making and existing and emerging methods to bridge the science-policy gap. The results of case studies of information production, communication, and use in decision-making in national and international organizations, such as the Canada Department of Fisheries and Oceans and the Gulf of Maine Council on the Environment, will be highlighted. The panel will also discuss the growing number of efforts by non-governmental organizations and the public to influence public policy decisions.

The panel will address three main questions:

> (1) Does information produced by governmental, intergovernmental, and non-governmental organizations reach policy makers and decision makers in an efficient and timely manner?
> (2) What are enablers and barriers to the use of marine environmental information at the science-policy interface?
> (3) Despite the continued push to expand our knowledge bases, how can we use the existing information that we have better, to inform policy- and decision-making aimed at seeking solutions to serious coastal and ocean problems?

Discussions in this panel are directly relevant to management of resources in the Bay of Fundy the themes of this BoFEP science meeting as communication of information is an important aspect of addressing issues such as the climate change and the Gulf of Maine/Bay of Fundy Tidal power development, the future of wild fisheries, marine protected areas, and improving ocean literacy and communications in the Bay of Fundy. It is anticipated that the panel and discussion will sensitize coastal and ocean practitioners to the critical role of information and information management (use and influence) in their practice, in Canada and specifically for the Bay of Fundy region.

Future Research in the Bay of Fundy and BoFEP's Role

Chair: Marianne Janowicz

Panelists:

- Graham Daborn (Acadia University)
- Bill Casey (MP, Cumberland-Colchester, Nova Scotia)
- Peter Wells (Dalhousie University)
- Sarah Chamberlain (BoFEP)
- Joshua McNeely (Maritime Aboriginal Peoples Council)

This panel will discuss future research needs in the Bay of Fundy, considering current and emerging issues affecting the bay. A focus of this panel discussion will be the role of BoFEP in facilitating future research: should BoFEP's role be primarily in communications; promotion and coordination of research; or other? As an organization that is primarily run by volunteers, how can BoFEP continue to function and have a meaningful role? All workshop participants are invited to contribute to this discussion.

ORAL PRESENTATIONS

SESSION AFTER FRIDAY PLENARY OPENING

Emerging Environmental Issues in the Bay of Fundy and Gulf of Maine

Peter G. **Wells**
International Ocean Institute-Canada, Dalhousie University, Halifax, NS (oceans2@ns.sympatico.ca)

This talk presents an overview of some of the emerging issues (already or newly recognized) in the Bay of Fundy and northern Gulf of Maine. It is a sequel to the theme paper on this topic prepared in 2010 for the Gulf of Maine Council on the Marine Environment (see www.gulfofmaine.org/2/resources/state-of-the-gulf-of maine-report/ and a talk on emerging issues given at Coastal Zone Canada 2014 in Halifax. Since then, a file has been kept of Fundy marine issues requiring revisiting (e.g., the various impacts of climate change, threats to biodiversity from invasive species) and appearing as new regional marine issues (e.g., right whale mortalities, plastics/micro-plastics pollution, changes in species distribution). A report is being prepared for Environment and Climate Change Canada, organized as per the DPSIR (driver-pressure-state-impact-response) framework, simplified as driver/pressures, state/impact and societal response/actions. Highlights of this report will be given. The aim is to stimulate discussion about the ecosystem health of the Bay of Fundy, the important emerging issues, and the immediate and longer term priorities for research, communication, integrated coastal management, and marine policy development in the rapidly changing oceanic environment.

SESSION: FISHERIES ECOLOGY & MANAGEMENT

Seabird Diets as Bioindicators of Atlantic Herring Recruitment and Stock Size: A New Tool for Ecosystem-based Fisheries Management

Lauren Scopel[1], Tony (A.W.) **Diamond[1]**, Stephen Kress[2], Paula Shannon[2] and Adrian Hards[3]
[1] *Atlantic Lab for Avian Research and Biology Department, University of New Brunswick, Fredericton NB (l.c.scopel@gmail.com, diamond@unb.ca)*
[2] *National Audubon Society, Seabird Restoration Project (swk3@cornell.edu, pshannon@audubon.org)*
[3] *University of New Brunswick, Fredericton NB*

Ecosystem-based fishery management requires understanding of relationships between exploited fish and their predators, such as seabirds. We used exploratory regression analyses to model relationships between Atlantic herring (*Clupea harengus*) in the diet of seabird chicks at nine nesting colonies in the Gulf of Maine, and four types of fishery- and survey-derived herring data. We found several strong relationships which suggest spatial structuring in herring stocks and likely patterns of herring movements before they recruit into the fishery. Some types of herring data seldom used in stock assessments – notably acoustic surveys, fixed-gear landings, and weight-at-age – correlated as strongly with seabird data as more commonly used series, such as mobile-gear landings and modeled spawning stock biomass. Seabird chick diets collected at specific locations thus offer a promising means to assess the size, distribution, and abundance of juvenile herring across a broad area prior to recruitment, which is a major source of uncertainty in fisheries. Common terns (Sterna *hirundo*) showed the most potential as a bioindicator, correlating well and showing consistent spatial patterns with 11 of 13 fishery data series.

Local Events, Regional Context: Herring (*Clupea harengus*) Stock Depletion off Southwest Nova Scotia and Humpback Whale (*Megaptera novaeangliae*) Mortalities

Guy E. **Melville**
Freeport, NS (cgmelville@hotmail.com)

In December 2016 dead herring washed up on several shores in the Bay of Fundy region of western Nova Scotia. A dead juvenile humpback whale, a herring predator, came ashore in the same area. The events elicited considerable public comment, speculation, even protest. As a presumed density-independent phenomenon, the herring mortality event was minuscule. The tiny scale of the herring kill suggests very low numbers of herring in the area at the time, consistent with abundance indicators for the whole northeast Gulf of Maine. Seiner catches, for example, declined by 57% in significant linear fashion, or 2.3% y^{-1}, between 1990 and 2014 in NAFO 4VWX. Polynomials refine the temporal relationships, and point to multiyear lags between changes in rates of decline in fishing effort and subsequent seiner catches. Deaths of humpback whales, many juvenile, have increased dramatically in the last few years over a stretch of the Atlantic coast which includes the northeast Gulf of Maine. Causes of many of the deaths in this "Unusual Mortality Event" (NOAA) have not been established. However, the protracted overexploitation of herring has at very least stripped the pelagic food web of the northeast Gulf of Maine of its capacity for ecological resilience. This result contributes to the deaths of juvenile humpbacks, both directly and indirectly by way of foraging behaviour which increases vulnerability to ship strikes. The essence of this failing fishery has not changed over the years, shrouded in a facade of science and systemic mismanagement.

Comparison of the Physical Characteristics of Two Populations of Atlantic Sturgeon in Minas Basin: Kennebec and St. John Distinct Populations Segments

Jessie M**. Lilly**[1], Laura M. Logan-Chesney[2], Michael J. Dadswell, and Michael J.W. Stokesbury
[1] *Acadia University, Wolfville, NS (146558l@acadiau.ca)*
[2] *Acadia University, Wolfville, NS (laura.logan.chesney@gmail.com)*

Approximately 9,000 Atlantic Sturgeon, *Acipenser oxyrinchus oxyrinchus* Mitchill, 1815 aggregate in Minas Basin, Nova Scotia during the summer to feed on the rich abundance of bethnic invertebrates. Since 2010, the Coastal Ecology Lab at Acadia University has collected data regarding the stock composition, feeding behaviors, and movement patterns of threatened and endangered Atlantic Sturgeon in Minas Basin. DNA analysis indicated that 61% of Atlantic Sturgeon in Minas Basin originated from the Saint John River, 34% originated from the Kennebec River, and 2% were from the Hudson River, with the remaining originating from the James River. The aim of this study was to combine acoustic telemetry data and genetic data of Atlantic Sturgeon captured, tagged and released from 2010-2014 in Minas Basin, to determine if there is was a difference in the physical characteristics, or migration timing of the Saint John River and Kennebec River origin fish. Using an independent samples t-test measures of fork length between the Kennebec (mean= 135.64cm, sd= 16.241, n=81) and the St. John population (mean = 127.13cm, sd= 24.091, n=135) were compared. There was a significant difference in fork length between the two populations (t= 2.7383, df= 211.02, p=0.0067). The differences in the size of Atlantic Sturgeon entering the basin between the two populations could indicate that these populations migrate through the Basin at different stages in their life cycle. Having a better understanding of differences between distinct populations is needed to implement proper fishery regulations to conserve this species.

Nutrient Transfer: How Marine-Derived Nitrogen and Phosphorus from Alewife (*Alosa pseudoharengus*) Spawning Migration Benefit Freshwater Wetlands in Atlantic Canada

Jillian A. **Hunt**, Nic R. McLellan, George Nau, and Michael J.W. Stokesbury
Acadia University, Wolfville, NS (146108h@acadiau.ca)

Alewife (*Alosa pseudoharengus*) migrate from the ocean into freshwater ecosystems annually to spawn. During their migration, Alewife transfer important nutrients (mainly nitrogen [N] and phosphorus [P]) in the form of reproductive matter, carcasses, and excretory wastes that help maintain productive coastal wetland ecosystems. The aim of this project is to understand how Marine Derived Nutrients (MDN) from spawning Alewife integrate into the food web of two lakes in New Brunswick and Nova Scotia. We will use Stable Isotope Analysis (SIA) to determine the spatial and temporal distribution of marine-derived N and P in freshwater ecosystems from the Alewife spawning migration. SIA of samples from freshwater zooplankton will provide information on MDN distributed in the water column from excretion. Samples from macroinvertebrates (Leeches *Hirudinea* and snails *Gastropoda*) will provide information on MDN input from decaying carcasses, sperm and eggs. I hypothesize that MDN levels of three groups (zooplankton, leeches and snails) will be elevated in the spawning area, then gradually become uniform throughout the lakes and dissipate as the year progresses. This pattern will be repeated annually. Results will be crucial for wetland and anadromous fish conservation efforts by determining how MDN are integrated into the freshwater food web and how long they remain a driver of production for those food webs. The data from this project will be used by wetland conservation organizations and fishery managers to protect anadromous fish and their spawning habitats.

Sea Cucumber (*Cucumaria frondosa*) Population Dynamics for Improved Resource Management within Fishing Areas

Danni L. **Harper**[1], Naiff D. Bethoney[2], Kevin Stokesbury, Mark Lundy, and Michael J.W. Stokesbury
[1] *Acadia University, Wolfville, NS (144504h@acadiau.ca)*
[2] *School for Marine Science and Technology, University of Massachusetts Dartmouth, New Bedford, MA*

With global demand for sea cucumber products increasing and tropical stocks collapsing, it has opened a unique economic opportunity for Atlantic Canada where *Cucumaria frondosa*, or the Orange-Footed Sea Cucumber, are plentiful. *Cucumaria frondosa* is a filter feeding sea cucumber that ranges in colour from purple to orange and has ten orange tentacles it uses for feeding. These sea cucumbers grow slowly, reaching a maximum length and weight of 50cm and 500g respectively. Sea cucumber fisheries have been developing off the coast of Eastern Canada for the past decade or so, but their population dynamics remain largely understudied. Fisheries in Newfoundland and Labrador, Quebec, New Brunswick, and Nova Scotia, are managed separately, with some management regimes based on more and better data than others. In the Passamaquoddy Bay, many studies have been carried out looking at life history characteristics of *C. frondosa.* Although this life history information is central to proper management, other critical metrics for determining population dynamics are still lacking. To properly manage these sea cucumber populations, abundance and biomass, which are crucial to calculating catch quotas, must be estimated. These parameters must be understood to allow for sustainable catch in the long term. To make these estimates, we are conducting drop-camera video surveys of the fishing areas on the Scotian Shelf. With these videos and still photography we can calculate both abundance and biomass, as well as look at habitat preferences and proximity to predators. These new assessment methods, in conjunction with data from ongoing surveys, may be useful in other sea cucumber fisheries in eastern Canada as well, including in the Bay of Fundy.

Small Harpacticoid Copepod the Principal Prey of First Feeding Larval Striped Bass (*Morone saxatilis*) in the Shubenacadie River Estuary

Kamryn R. **Findlay**[1], Nasif Sarowar, Juan Manriquez-Hernandez, and Jim Duston
[1] *Department of Animal Science & Aquaculture, Dalhousie University Faculty of Agriculture, Truro, NS (kamryn.findlay@dal.ca)*

To determine the zooplankton abundance and potential prey of larval striped bass in the Shubenacadie River Estuary, quantitative plankton net tows were conducted in the upper-estuary (river km 25 to 40) every 3 to 4 days from May–July 2016–2017. Striped bass eggs hatched in about 2 days after spawning and larvae reached the first-feeding stage in about 5 days (5–6mm total length, TL). Highest mean weekly abundance of post-yolk-sac larvae was 463/m^3 May 29–June 4, 2016, and 595/m^3 June 12–18, 2017. Larvae failed to grow and had empty stomachs for about two weeks due to lack of suitable prey. The first prey items in the stomach among 99% (out of 870) of larvae was a small (<1mm TL) adult stage harpacticoid copepod from the family Ectinosomatidae and could possibly be *Halectinosoma* sp. or *Pseudobradya* sp. Mean peak abundance of this copepod was 200–250/m^3 in salinities of 1.1–2.0ppt during June 2017. Once the striped bass started feeding and growing, other copepods in the stomach contents included *Diacyclops bicuspidatus*, *Pseudodiaptomus pelagicus*, and *Coullana canadensis*. The copepod diversity of the macrotidal Shubenacadie River Estuary contrasts with stratified coastal striped bass nursery habitats along the Eastern seaboard where *Eurytemora affinis* is the main prey.

Fallen Angelwing (*Barnea truncata*), a Disjunct Mollusc Species of the Minas Basin and Bay of Fundy: Known Biology, Substrate Constraints, Coarse Scale Distribution and Conservation Status

Andrew **Hebda**[1] and Caira Clark[2]
[1] *Nova Scotia Museum, Halifax, NS (andrew.hebda@novascotia.ca)*
[2] *Population Ecology Division, Science Branch, Fisheries and Oceans Canada, Dartmouth, NS (caira.clark@dfo-mpo.gc.ca)*

The Fallen Angelwing (*Barnea truncata*), found in the Minas Basin and Cobequid Bay is mollusc species with an Amphi-Atlantic Distribution. The Canadian occurrence approximately 500 kilometers from the nearest (southern) occurrence is restricted to a single substrate type in limited portions of the intertidal zone of the basin and bay, a Triassic era mudstone. Due to its inability to move once it has settled, it is subject to site-specific elimination through changes in substrate deposition and sediment movement. As such, its occurrence should be considered a significant indicator of both local scale as well as gross scale changes in energy regimes/sediment deposition within this ecosystem.

As of May, 2017, it is listed as threatened under the *Species At Risk Act*, consequently clear knowledge of its current distribution, life history traits and habitat constraints is essential in the evaluation of activities which may result in changes in energy regimes and patterns and in sediment re-distribution within the ecosystem. A review of its known biology, substrate constraints, coarse scale distribution and conservation status is presented.

SESSION: INTEGRATED COASTAL MANAGEMENT

Common Issues, Common Goals: Increasing Collaborations in Habitat and Resource Conservation

Maja **Reinhartsen**[1] and Trevor Avery[2]
[1] *M.Sc. Candidate, Biology Department, Acadia University, Wolfville, NS (majareinhartsen@acadiau.ca)*
[2] *Departments of Biology and Mathematics & Statistics, Acadia University, Wolfville, NS (trevoravery@acadiau.ca)*

A history of overexploitation in regional fisheries and vulnerability to effects of climate change form the basis for growing support of an anticipatory approach to management of marine resources within an ecosystem-based framework. To boost the effectiveness and adherence to marine policies, conserve resources for future use, and combat climate-related environmental changes, knowledge holders must be better engaged in current issues. The disconnect between community members with local and traditional expertise (LEK) related to Minas Basin fisheries and watersheds, and resource management agencies, forms a barrier to effective management. I propose to collect, compile, and assess LEK in conjunction with standard scientific principles of ecosystem management related to fisheries. The directive will support creation and adoption of integrative and collaborative protocols for community-level resource oversight and knowledge sharing. Specifically, the research will focus on solutions for better fish passage at tidal barriers in Minas Basin. Extrapolation and application of LEK data to explore changes in fish distributions, demographics and fisheries data collection methods is of growing significance and of regulatory interest.

The significance of this project includes a record of fisheries LEK in the local waterways with significant fish migration activity and barriers to habitat access. Development of relationships between LEK and various environmental indicators is a critical component of the research and may help create standards for using LEK along with long-term data trend compilation. Based on these relationships, capacity building for fishers to be active in cooperative management will be explored. The outcomes include compilation of data to inform target and non-target fisheries conservation actions, increased stewardship for at-risk species conservation through Citizen Science initiatives, and dissemination of analyses to Fisheries and Oceans Canada, local fishers and First Nations groups.

Working with Recreational Users to Reduce Disturbance to Migratory Shorebirds during High Tide Roosting Periods in the Minas Basin, Nova Scotia

Jaya **Fahey**[1], Sue Abbott[2], Rebekah Persad[3], Karen Beazley[4] and Kate Sherren[5]
[1]*Dalhousie University, Halifax, NS (jaya.fahey@dal.ca)*
[2]*Bird Studies Canada, Dartmouth, NS (sabbott@bsc-eoc.org)*
[3]*University of Waterloo, Waterloo, ON (rebekah.persad@edu.uwaterloo.ca)*
[4]*Dalhousie University, Halifax, NS (karen.beazley@dal.ca)*
[5]*Dalhousie University, Halifax, NS (kate.sherren@dal.ca)*

Migratory shorebird numbers are dropping worldwide, making shorebird conservation a necessity. Although it is obvious that conservation must incorporate human values, it is uncommon to develop strategies with those seen as causing conservation challenges. We identified four sites in the Minas Basin where human-caused disturbance to shorebirds resulted in a decrease in roosting time, as the birds walked or flew away from the disturbance. Resting time, when mudflat feeding grounds are covered by water, is vital to the birds' survival as they continue their migration to South America. Through site audits in August 2016, we identified walkers, anglers, bird watchers, photographers, bathers, swimmers and dog-

walkers as the users causing shorebird disturbance. The two sites with the largest flocks, highest number of disturbance events and most interest from local users were chosen as pilot sites for conservation strategies in 2017. Through questionnaires, an online-survey, education and outreach, we worked with users to identify and set aside a dedicated 'Shorebird Resting Beach' at each of the two sites. Through signage, handouts and researcher presence, we asked users to avoid these two beaches from two hours before and after high tide in August 2017. Based on 15 audits at each site, we found that human-caused disturbance was reduced from 2016 at the 'Shorebird Resting Beach' at site one, and remained the same at site two. These data, along with user-interviews, will allow us to assess the effectiveness of our materials and re-implement in August 2018, with the aim of further reducing human-caused disturbance.

Moving towards Sustainable Social-Ecological Systems within the Bay of Fundy: Investigating Opportunities for Integrated Coastal and Marine Management

Sondra L. **Eger**
University of Waterloo, Waterloo, ON (seger@uwaterloo.ca)

Despite being a popular approach globally, operationalizing (i.e., developing, implementing and evaluating) integrated coastal and marine management (ICM), an approach that moves beyond sector-based management, has proven difficult within coastal and marine social-ecological systems (SES) in Canada. The purpose of this study is to determine the role of coastal communities in catalyzing a shift towards sustainable coastal and marine SES in the Bay of Fundy.

Research shows the consideration of coastal community perspectives, in addition to natural science perspectives, strengthens the development of integrated coastal and marine management (ICM) initiatives and increases the likelihood of success; however, there remains a research gap to better understand how to incorporate coastal community perspectives and capacity into ICM initiatives. The following research objectives will assist in addressing this gap: 1) synthesize past ICM experiences in Atlantic Canada; 2) assess ICM initiatives within the Bay of Fundy; 3) integrate community perspectives on critical barriers and opportunities for ICM within Bay of Fundy; and, 4) develop a suite of recommendations for moving towards positive and desired ICM outcomes in the Bay of Fundy.

This research involves multiple methods and will be completed over the summers of 2018–2019. A systematic review, regional and community-based interviews and participatory planning workshops will be conducted to determine the role of coastal communities in ICM within the Bay of Fundy. As place-based problems often demand place-based solutions, my research aims to enhance the sustainability of coastal SES through a better understanding of how local-regional capacity could complement federal actions through ICM initiatives to enhance operationalization success.

Coastal Communities and Third-Eye Science: Academia, Fisheries and First Nations in the Bay of Fundy, Nova Scotia, Canada

Brendal A. **Townsend**[1] and Nikki Beauchamp[2]
[1]*Ocean Tracking Network, Dalhousie University, Halifax, NS (brendal.townsend@dal.ca)*
[2]*Ocean Tracking Network, Dalhousie University, Halifax, NS (n.beauchamp@dal.ca)*

Fishing weirs have traditionally fostered a unique setting of communal support, food sustenance, and sense of place. The Bramber Weir in Minas Basin, Nova Scotia, is both a commercial weir and a centre for learning about local wildlife and habitats. Originating as a commercial site, the weir has now

expanded to include traditional, local and academic knowledge, known as “Third-Eye Science”, hosted under the umbrella of the Marine Institute of Natural and Academic Science (MINAS). The incorporation of traditional knowledge in conservation, research, and management is unique among Fundy weirs, helping maintain the productivity and vitality of ecosystems from which Indigenous communities draw their livelihoods and sense of community.

This film documents the partnership between MINAS, a grassroots organization composed of community stakeholders, including First Nations, dedicated to improving the integration of traditional knowledge into academic-led research, and the Dalhousie University-based Ocean Tracking Network (OTN), a global science platform focused on using acoustic telemetry to track the movements and survival of aquatic species.

Integrating “Third-Eye Science” with acoustic telemetry provides a greater capacity to track biodiversity, and to document the movements and survival of aquatic species in response to anthropogenic stressors. MINAS and the Bramber Weir are leaders in generating community-driven data (citizen science), knowledge mobilization and management actions that address concerns at the ecosystem level, by those who understand it best—the people that live there.

SESSION: TIDAL ENERGY

Tidal Energy Demonstration in the Minas Passage, Bay of Fundy

Tony **Wright**[1], Melissa Oldreive[2] and Sandra Currie
[1] *Fundy Ocean Research Center for Energy, Halifax, NS (*tony.wright@fundyforce.ca*)*
[2] *Fundy Ocean Research Center for Energy, Halifax, NS (*melissa.oldreive@fundyforce.ca*)*
[3] *Fundy Ocean Research Center for Energy, Parrsboro, NS (*sandra.currie@fundyforce.ca*)*

The Fundy Ocean Research Center for Energy (‘FORCE’) is a non-profit organization that owns and operates Canada’s leading research centre for in-stream tidal energy, located in the Minas Passage of the Bay of Fundy. In particular, FORCE acts as a host that allows demonstration devices to connect to the electrical grid, and also as a steward, providing research and monitoring to better understand the interaction between these devices and the environment.

In addition to conducting environmental effects monitoring activities related to marine mammals, fish, lobster, seabirds, and turbine-related noise, FORCE also conducts innovative research initiatives through the Fundy Advanced Sensor Technology (FAST) program to improve site characterization, environmental monitoring, and marine operations methodologies. Through these efforts as well as welcoming ~4,000 visitors at its site per year, FORCE has a role to play in supporting informed, evidence-based decisions by regulators, industry, the scientific community, and the public regarding the role tidal energy could play in Canada’s energy future.

Environmental Monitoring, Modelling and Forecasting for Instream Tidal Energy Development at the FORCE Test Site

Richard Karsten[1], Alex Hay[2], David Barclay[2], Paul Hill[2], Andrew Gerber[3], Tiger Jeans[3], Joseph Hall[3], Len Zedel[4], Michael J. W. Stokesbury[5], Elizabeth **Nagel**[1] and Anna M. Redden[1,5]
[1] *Acadia Tidal Energy Institute, Acadia University, Wolfville, NS (richard.karsten@acadiau.ca, elizabeth.nagel@acadiau.ca, anna.redden@acadiau.ca)*

[2] *Department of Oceanography, Dalhousie University, Halifax, NS (alex.hay@dal.ca, dbarclay@dal.ca, paul.hill@dal.ca)*
[3] *Department of Mechanical Engineering, University of New Brunswick, Fredericton, NB (agerber@unb.ca, tjeans@unb.ca, jwhall@unb.ca)*
[4] *Physics & Physical Oceanography Department, Memorial University, St John's, NL (zedel@mun.ca)*
[5] *Biology Department, Acadia University, Wolfville, NS (michael.stokesbury@acadiau.ca)*

Canada has in the Bay of Fundy one of the world's richest tidal resources and a world-leading test site for large grid-connected in-stream tidal turbines. But decisions regarding the development and regulation of the tidal energy industry are hindered by a lack of scientific evidence related to animal/turbine interactions and flow variability. The primary goal of the research planned for 2018–2023 is to address the two challenges facing tidal energy development: the impact of the environment on turbines and the impact of turbines on the environment. Both require a highly integrated suite of field work infrastructure that will quantify the high-flow, dynamic environment of Minas Passage, including measuring flow velocities, mapping the sea bottom, detecting the presence of marine mammals, tracking fish and monitoring the noise generated by turbines. Both challenges also require substantial computing infrastructure to conduct high-resolution numerical simulations and to analyze the large quantities of collected data. Field projects will utilize robotic watercraft, drifting buoys and a rigid-inflatable boat, all outfitted with acoustic devices to measure flow speed, turbulence, underwater noise and seabed change, and drones to provide video aerial imagery. State-of-the-art, fish-tracking technology and imaging sonars will collectively give a detailed picture of how fish and marine mammals interact with turbines. Together, the system will quantify and map the spatial distribution of turbulence, noise and marine animals at the FORCE test site. To complement the field work, high-end computing infrastructure will be used to run simulations of turbines operating in the turbulent flow field, to generate accurate ocean forecasts necessary for marine operations and to simulate the impact of commercial-scale turbine arrays on marine life.

Using RADAR as a Spatial Mapping Tool for Surface Velocity and Turbulence Detection

Jeremy G. **Locke**[1] and J. Culina[2]
[1]*Acadia University, Wolfville, NS (jeremylocke@acadiau.ca)*
[2] *Fundy Ocean Research Centre for Energy, Halifax, NS (jculina@fundyforce.ca)*

Traditionally the method to estimate spatial variation of surface velocity or turbulence intensity in a region of interest has been done using a combination of Drifters, Acoustic Doppler Current Profilers (ADCPs) and simulated model data. Drifters and ADCPs are used to collect field data at specific points within a region of interest. Field data are then used to validate simulated model data which in turn are used to approximate spatial maps of surface velocity or turbulence intensity for the region of interest. Pioneered by Dr. Paul Bell in the United Kingdom, RADAR can be used extract data across an entire region of interest simultaneously. This is done by collecting RADAR backscatter data from waves in the region then applying post-processing algorithms to extract velocity and turbulence information. The method, limitations, and initial results of applying Dr. Bell's method to the Crown Lease Area (CLA) in the Minas Passage will be presented.

Acoustic Detection of Fish Density and Vertical Distribution and Relationships with Flow Conditions at the FORCE Tidal Energy Test Site

Haley A. Viehman[1,2], Tyler Boucher[2] and Anna M. **Redden**[1]
[1] *Acadia Centre for Estuarine Research, Acadia University, NS (*haley.viehman@acadiau.ca, *anna.redden@acadiau.ca)*
[2] *Fundy Ocean Research Center for Energy, Halifax, NS (tyler.boucher@fundyforce.ca)*

The effects on fish of marine hydrokinetic (MHK) devices at high flow sites are generally unknown, but of high concern to industry, regulators, the scientific community, fishers and other stakeholders. The goal of this project was to acoustically assess the seasonal vertical distribution of fish at the FORCE site and consider the implications for the likelihood of interactions with the Cape Sharp Tidal MHK device (OpenHydro), which spans 0 to 20 m above the sea floor. Hydroacoustic data were collected with an upward-facing Acoustic Zooplankton and Fish Profiler (AZFP) on a FORCE sensor platform, deployed for one-month intervals at the FORCE site in December 2015 and June 2016. Data were processed to remove unwanted signal, including entrained air near the surface. The data were split into individual tidal stages (ebb or flood) and partitioned into cells 1 m thick, measured upward from the sea floor. The proportion of area backscatter (a proxy for fish density) contributed by each layer of the water column was compared for time periods of interest, for example, day vs. night and ebb tide vs. flood tide, for each season examined. The proportion of backscatter at turbine depth (0 to 20 m above the sea floor) was used to assess seasonal differences in the likelihood of fish encountering the tidal turbine. The correlation between current speed (as determined using an upward-facing Signature 500 ADCP) and fish density (using the AZFP) was also examined for relationships with environmental factors, including tidal and diel stages and water column depth. This ongoing work is contributing to a better understanding of how fish distribution and density relates to hydrodynamic conditions at high-flow sites and is informing predictions of the probability of fish encounters with MHK devices in the Minas Passage.

Quantifying Fish-Turbine Overlap Using High Residency Acoustic Electronic Tagging Technology

Michael J.W. **Stokesbury**[1], Brian G. Sanderson[2], Rod G. Bradford[3], A. Jamie Gibson[3], David C. Hardie[3], Anna M. Redden[2], Jessie M. Lilly[1] and Montana F. McLean[4]
[1] *Acadia University, Wolfville, NS (mike.stokesbury@acadiau.ca)*
[2] *Acadia Centre for Estuarine Research, Acadia University, Wolfville, NS*
[3] *Bedford Institute of Oceanography, Fisheries and Oceans Canada, Dartmouth, NS*
[4] *Biology Department, Dalhousie University, Halifax, NS*

There is a lack of scientific data on the potential effects of instream tidal power development on resident and migratory fishes in the Bay of Fundy. It remains unclear if fishes that occupy Canada's leading tidal energy test site in Minas Passage, will be negatively affected by turbine operation. This void in knowledge exists, in great part, because there has been a lack of technology capable of addressing questions on animal movement and behaviour in areas where tidal current speeds are extreme (often >6m/sec). When predicting possible effects of turbine operation on listed endangered species (i.e., iBOF Atlantic salmon, great white shark) where the loss of one individual may have a negative impact on the population, effects are assessed on the individual level. For plentiful species, it is critical to have an estimate of population or relative abundance, so individual losses can be put into context to predict the fate of the population. In this study, we will use new, high residency acoustic fish tracking technology to attempt to quantify spatial and temporal overlap of one endangered (Atlantic salmon) and three plentiful (alewife, striped bass and Atlantic sturgeon) species with areas chosen for the operation of in-stream tidal

turbines. This study will provide information central to predicting overlap of migratory fishes with areas of future tidal power extraction.

Passive Acoustic Drift Surveys of Harbour Porpoise (*Phocoena phocoena)* Presence and Behaviour in the Minas Passage and Adjacent Waters

Mike J. **Adams**[1,2], Anna M. Redden[1,2] and Brian G. Sanderson[2]
[1] *Biology Department, Acadia University, Wolfville, NS (119559a@acadiau.ca, anna.redden@acadiau.ca)*
[2] *Acadia Centre for Estuarine Research, Acadia University, Wolfville, N S (bxs@eastlink.ca)*

Atlantic harbour porpoises, *Phocoena phocoena*, are small, echolocating toothed whales (Suborder Odontoceti) commonly found in the Bay of Fundy, including the Minas Passage. Porpoise click trains used for echolocation were monitored in Minas Channel and Minas Passage using two synchronized icListenHF hydrophones suspended under a drifting spar-buoy. Six 4-6 hour long drifts were completed in June 2017. Data from the two hydrophones showed that porpoises spent about as much time below 15 metres as above; therefore, interactions with tidal turbines at FORCE cannot be dismissed. Porpoise clicks have a frequency of about 130 kHz, duration of about 100 microseconds, and are commonly separated by about 0.1 second when navigating. We observed lower amplitude (~130 kHz) signals of much longer duration with complex modulation that were interspersed between navigating clicks. Such signals may indicate communication, perhaps between mother and calf. Feeding buzzes (high-rate clicking) were observed and had a patterned structure with tightly spaced clusters of 2-4 clicks. Visual porpoise sightings compared well with acoustic detections except near Cape Split where extreme tidal conditions limited visual observations. Future drift studies will focus on expanding the passive acoustic monitoring of porpoises in the Minas Channel and Minas Passage, by using an array of six hydrophones. This larger array will permit calculation of the precise depth of a porpoise and its distance from the hydrophones. Depth and range make it possible to attribute echolocation clicks to an individual porpoise, allowing determination of the porpoise density close to and away from the turbine. Such results are required for estimating porpoise-turbine encounter rate.

Social Licence and Tidal Energy Development in Nova Scotia, Canada

Caitlin **Peace-Williams** and John Colton
Acadia University, Wolfville, NS (102303p@acadiau.ca, john.colton@acadiau.ca)

Nova Scotia is a global example of a region taking advantage of its vast tidal energy resources through tidal energy testing and development. Alongside innovations in tidal energy technology, social economic factors must also be considered, especially the extent to which a social license has been developed. Social licence, which is the ongoing approval or social acceptance of a project in a community, must be developed for communities to support and approve of a project or development. This research explores factors that support the development of social licence in the context of tidal energy in Nova Scotia, Canada. These factors include the importance of public education, the significance of baseline research, an understanding of the technology and its impacts, as well as the role of community and economic development. Interviews with a variety of key stakeholders in tidal energy development provide insight into the role these four factors play in supporting a social license. While these four factors are significant, other factors are critical as well and include legitimacy, credibility, and trust.

SESSION: DYKELANDS AND TIDAL WETLAND RESTORATION (Thursday)

The Nova Scotia Department of Agriculture's Management Plan for Nova Scotia Dykeland System

Christopher **Ross**
Land Protection, Nova Scotia Department of Agriculture, Truro, NS (christopher.ross@dal.ca)

The Nova Scotia Department of Agriculture (NSDA) is developing a management plan for the Provincial Dykeland System in response to climate change projections and aging infrastructure. A focus on risk assessments, geotechnical considerations and effective management of capital investments will help modernize management of the Dykeland System and marshland it protects. Projects in 2017–2018 include the Fundy Dyke Agricultural Risk Assessment in partnership with New Brunswick under the National Disaster Mitigation Program; Risk Proofing Nova Scotia Agriculture in partnership with the Nova Scotia Federation of Agriculture; and Fundy Agricultural Marshland Flood Maps, also with New Brunswick.

The presentation will demonstrate NSDA's approach for the effective management and protection of agricultural lands, including marshlands and dykelands, by ensuring a continuum of engineering standards, utilizing a participative process providing technical and advisory resources inclusive of local, traditional knowledge and multi-disciplinary teams applying best available evidence-based practices. Under the *Agricultural Marshland Conservation Act*, NSDA is legislated to supervise and manage the agricultural dykeland assets. The infrastructure consists of 240 kilometers of dyke and 246 aboiteaux along the Bay of Fundy, and protects 18,995 hectares of land located on 82 agricultural marshlands. Improved dykeland management is aimed at reducing climate-related hazards and disaster risks such as coastal flooding and erosion in vulnerable regions – Indigenous, costal, remote communities and marshlands areas. The presentation will support stakeholder and technical presentations featured on the Dykeland System as well.

Vulnerability Assessment of Dyke Infrastructure in the Bay of Fundy

Danika **van Proosdij**[1] and Christopher Ross[2]
[1] *Department of Geography and Environmental Studies, Saint Mary's University, Halifax, NS (dvanproo@smu.ca)*
[2] *Maritime Provinces Spatial Analysis Research Center, Saint Mary's University, Halifax, NS*

The purpose of this project was to assess the vulnerability and probability of dyke overtopping and/or failure in dykeland areas in Nova Scotia within the Bay of Fundy, to help inform decision making by the Nova Scotia Department of Agriculture. Analysis was performed using updated surveyed dyke elevations, newly released Lidar elevations from the Province, and other attribute data within the Dykeland Decision Support Tool (DDST). Vulnerability to overtopping and/or failure was identified as a function of water depth, crest elevation, exposure, foreshore marsh width, platform elevation and form (ramped versus cliffed), and presence or absence of armouring. Dykes were divided into 25 m segments and attributes assigned per segment using an automated process in ArcGIS 10.5.1. Based on the analysis, dyke tracks were coded into categories of low to high risk and viewed in conjunction with a companion project identifying assets as risk. Historical patterns of erosion and progradation over the last 60 years were quantified for the 1671 individual marsh units fronting 240 km of agricultural dykes in the Province. As seen elsewhere in the region, cyclical patterns of erosion and progradation were observed within each Basin however the impacts of human action on this process (e.g., armouring, engineering, dredging) were evident. Ecomorphodynamic principles were then applied to identify areas of foreshore marsh that had the

greatest or least likelihood of continuing to provide natural forms of coastal defense in the future, and time period over which this would occur.

Truro Flood Risk Study: Looking for Sustainable Flood Protection

Alexander **Wilson**[1], V. Lyes[1], R. Giffin[1], G. Smith, A. Gates[1], J. Forbes[1], V. Fernandez[1], J. Marvin[1], M. Burke[1], A. Thibault[1] and Danika van Proosdij[2]
[1] *CBCL Ltd. Consulting Engineers (alexanderw@cbcl.ca)*
[2] *Intertidal Coastal Sediment Transport Research Unit, Department of Geography and Environmental Studies, Saint Mary's University, Halifax, NS (dvanproo@smu.ca)*

Truro is notorious for being subject to the most frequent flood events of any developed area in Atlantic Canada. All previous assessments had pointed to the difficulty in resolving the complex interaction between the highest tides in the world, very large runoff flows, river sedimentation and recurring ice jams. Millbrook First Nation, the County of Colchester and the Town of Truro leveraged provincial funding to commission this ambitious study and attempt to develop clear answers based on sound science.

The Truro Flood Study is the most comprehensive flood study ever undertaken in Atlantic Canada. One of its main goals was to incorporate the latest computer techniques that built upon the most detailed information recently available (Lidar mapping for the entire watershed, seasonal sediment characterization, bathymetric surveys and velocity profiling). One-D, 2D and 3D hydrodynamic and ice jam models were used to study the relative influence of extreme rainfall, macrotidal conditions, sedimentation in the estuary and ice jams, which all play a role in creating high risks of flooding in the area. Climate change impacts were also studied, a clear departure from previous flood study results.

Striking a Balance: Application of Coastal Habitat Restoration for Climate Change Adaptation

Tony **Bowron**[1], Danika van Proosdij[2], Jennie M. Graham[1], Ryan Mulligan[3], Christopher Ross[4], Kevin Bekkers[5] and Robert Pett[6]
[1] *CBWES Inc., Halifax, NS (tony.bowron@cbwes.com)*
[2] *Department of Geography and Environmental Studies, Saint Mary's University, Halifax, NS (dvanproo@smu.ca)*
[3] *Department of Civil Engineering, Kingston, ON (ryan.mulligan@queensu.ca)*
[4] *Maritime Provinces Spatial Analysis Research Center, Saint Mary's University, Halifax, NS (christopher.ross@smu.ca)*
[5] *Nova Scotia Department of Agriculture, Agriculture and Food Advisory Services, Land Protection, Truro, NS (kevin.bekkers@novascotia.ca)*
[6] *Nova Scotia Department of Transportation and Infrastructure Renewal, Halifax, NS (bob.pett@novascotia.ca)*

The conservation, restoration and use of vegetated coastal habitats in eco-engineering solutions for coastal protection are increasingly being accepted as providing a promising strategy, delivering significant capacity for climate change mitigation and adaption. Coastal habitats provide a range of climate change adaptation and ecosystem services including erosion protection, stormwater retention and filtration, land and habitat creation and carbon storage. Globally, the practice of re-introducing, where feasible, tidal flow to former dykelands and the restoration of tidal wetland habitat, has been identified as a viable adaptation method to current and future risks associated with climate change. In addition, there is increasing recognition of the potential of restored salt marshes to provide 'blue carbon' benefits. With limited

resources available, guidance is required to determine which dykes to remove that will optimize ecosystem services while providing climate change adaptation benefits, minimize economic costs yet still maintain fertile agricultural land and social, cultural and historic activities. Pending and on-going managed realignment projects in Nova Scotia (i.e., Truro-Onslow realignment and tidal wetland restoration project) will be used as a framework for discussion on challenges and opportunities presented for coastal habitat restoration for climate change adaptation.

Building on Ten Years of Experience to Design the Truro-Onslow Dyke Realignment and Tidal Wetland Restoration Project

Jennie M. **Graham**[1], Tony Bowron[1], Danika van Proosdij[2], Ryan Mulligan[3], Robert Pett[4] and Kevin Bekkers[5]
[1] *CBWES Inc., Halifax, NS (jen.m.graham@gmail.com; tony.bowron@cbwes.com)*
[2] *Department of Geography and Environmental Studies, Saint Mary's University, Halifax NS (dvanproo@smu.ca)*
[3] *Department of Civil Engineering, Queen's University, Kingston, ON (ryan.mulligan@queensu.ca)*
[4] *Nova Scotia Department of Transportation and Infrastructure Renewal, Halifax, NS (bob.pett@novascotia.ca)*
[5] *Nova Scotia Department of Agriculture, Agriculture and Food Advisory Services, Land Protection, Truro, NS (kevin.bekkers@novascotia.ca)*

Globally, the practice of re-introducing tidal flow, where feasible, to former dykelands and restoring tidal wetland habitat, has been identified as a viable adaptation method to current and future risks associated with climate change. Located at the confluence of the North and Salmon Rivers near the town of Truro, Nova Scotia, the Onslow North River Marshland provides an important opportunity to demonstrate the environmental and social benefits of a large-scale strategic dyke realignment project, as well as the benefits of a multidisciplinary and multi-stakeholder approach to tidal wetland restoration. Carried out in collaboration with the Nova Scotia Department of Agriculture (NSDA), Nova Scotia Transportation and Infrastructure Renewal, and the Onslow North River Marsh Body, this project included the realignment of the existing dyke, the dyke decommissioning and hybrid tidal creek network design, and the hydrodynamic modeling of restoration scenarios. This presentation will focus on the process and technical aspects of the project design and the expected outcomes of the realignment and restoration project, which include the restoration of ~80 ha of tidal wetland habitat, reduced flood risk, and reduced maintenance costs for NSDA.

Truro Salt Marsh Restoration: Learning Lessons About Communications, Collaboration, and Engagement

Jennifer A. **Graham**[1]**,** Tony Bowron[2] and Kevin Bekkers[3]
[1] *Nova Scotia Environment, Halifax, NS (jen.graham@novascotia.ca)*
[2] *CBWES Inc., Halifax, N S (tony.bowron@cbwes.com)*
[3] *Nova Scotia Department of Agriculture, Truro, NS (kevin.bekkers@novascotia.ca)*

Published research on strategic coastal realignment and salt marsh restoration emphasizes the importance of the bio-physical and economic outcomes of restoration work, including restored habitat and associated services and functions, as well as contributions to flood risk reduction. There is a growing body of social science work (Kaufman 2010) that highlights that activities are more likely to be successful when key

stakeholders report being engaged and empowered, work collaboratively with internal and external stakeholders, and receive an appropriate level of communications.

A unique aspect of salt marsh restoration/dyke realignment work in the Bay of Fundy is that any work to alter the established dyke boundaries requires approval from the affected Marsh Body. A Marsh Body is made up of property owners who own land within or adjacent to the dykeland. In this context, community buy-in is required before any physical work can begin.

This presentation will focus on the social process and outcomes of the Truro-Onslow Managed Realignment & Restoration Project. It will detail how the project team worked to establish effective Internal social processes as well as with the Onslow Marsh Body. Key elements included extensive and varied communication with partners and stakeholders; formal and informal collaboration between provincial government departments and external stakeholders, and efforts to engage with Marsh Body, municipality, and other interested parties. I will conclude by highlighting key outcomes, lessons learned on the integration of social processes into restoration work, and implications for future projects of this type.

With each of these models, more than 40 flood mitigation options were evaluated. Based on the extensive stakeholder consultations held at the beginning of the project, each option was ranked by its ability to cost-effectively protect the vulnerable areas that were vital to each of the stakeholders. Long-term sustainability of the options was a key factor in this analysis.

How Can Public Discourses Identified Using Q-Methodology Help Inform the Management of Bay of Fundy Dykelands Under Climate Change?

Kate **Sherren**
School for Resource and Environmental Studies, Dalhousie University, Halifax, NS (kate.sherren@dal.ca)

The Acadian dykelands of Nova Scotia represent an opportunity to explore the social and governance limits to coastal climate adaptation in cultural landscapes. A representative online Q-methodology survey of 183 adult residents of Nova Scotia was conducted in the spring of 2015. Respondents sorted 34 statements along a normal distribution ranging from agree to disagree, about whether they prefer dykeland maintenance or wetland restoration, and under what governance arrangements. The dominant discourse was local, female and strongly pro-dykeland, indicating the some likelihood of local resistance to dykeland removal for cultural, recreational as well as flood control reasons. The second factor was supportive of wetland restoration for reasons of efficiency, not wetland affinity, and was characterized by those in positions of management power. The two minority viewpoints were less informed about dykelands, characteristic of outsiders, and more concerned with governance. Results also suggest that more education is needed about the challenges and options facing dykelands and proposals should emphasize flood mitigation over cost-saving. Cultural associations and status quo bias are clearly barriers to adaptation planning. Theoretical development since this work on the concept of climax thinking offers several potential leverage points for framing landscape change in such contexts, but requires additional testing.

SESSION: MONITORING AND CONTAMINANTS

Mussels and Sediment as Monitoring Tools for Contaminants: Which to Use When?

Adria A. Elskus[1], Lawrence A. LeBlanc[2], James S. Latimer[3], David Page 4, Gareth Harding[5], Peter G. **Wells**[6], Donald Killorn[7] and Matthew Liebman[8]
[1] *USGS, Leetown Science Center, S.O. Conte Anadromous Fish Research Laboratory, Turners Falls, MA, USA (aelskus@usgs.gov)*
[2] *Lawrence LeBlanc Consulting, Conway, MA, USA (laleblanc@msn.com)*
[3] *US EPA, Office of Research and Development, Narragansett, RI, USA (latimer.jim@epa.gov)*
[4] *Bowdoin College, Brunswick, ME, USA (dpage@bowdoin.edu)*
[5] *Fisheries and Oceans, Bedford Institute of Oceanography, Dartmouth, NS (garethcharding@gmail.com)*
[6] *International Ocean Institute-Canada, Dalhousie University, Halifax, NS (oceans2@ns.sympatico.ca)*
[7] *Eastern Charlotte Waterways, Blacks Harbour, NB (dkillorn@ecwinc.org)*
[8] *US EPA, New England, Boston, MA, USA (liebman.matt@epa.gov)*

For decades, sediments and mussels have been used to assess the ecological and human health risks associated with concentrations of bioavailable organic and metal contaminants in a variety of coastal-wide and localized monitoring programs. Mussels (*Mytilus edulis*) bioaccumulate organic and metal contaminants from the water and sediment, whereas sediments serve as repositories for particle-active contaminants. In the Gulf of Maine (GOM), monitoring coastal contamination in both sediments and mussels has been done through area-wide monitoring programs such as Mussel Watch (NOAA) and the National Coastal Assessment (EPA) on the U.S. side. Gulfwatch, a joint Canadian–U.S. program, monitors contaminants in mussels at several sites to identify contaminant "hot spots" within the whole GOM. The need for sediment data from the Bay of Fundy prompted sediment collection in 2015 under the aegis of the EcoSystem Indicator Partnership from Gulfwatch stations along the Bay of Fundy coastline. Sediments were analyzed for a suite of organic and metal analytes, and bulk organic carbon. We compare mussel and sediment concentrations at several different sites in the GOM utilizing data from 2005–2015 from the above programs. Preliminary results show little correspondence between sediment and tissue contaminant concentrations of mussels collected in prior years at these same sites. Potential causes of this disconnect include space-time and geomorphology differences. We explore scenarios where one or the other matrix is better suited for describing environmental health. The factors that affect the utility of mussels vs. sediments as monitoring tools include spatial and temporal influences and the dynamics of their respective environments.

Cobble-Filled Bio-Collectors: a Tool for Detecting Changes in Biodiversity in a Difficult-to-Sample Habitat in the Bay of Fundy

Heather L. **Hunt**[1], Marie-Josée Maltais, Brent Wilson, Krystal Woodard, Curtis Forbes and Rémy Rochette
[1] *University of New Brunswick, Saint John, NB (hhunt@unb.ca)*

In the Outer Bay of Fundy, shallow cobble habitat harbours a diversity of species, and serves a nursery function for commercially important species such as the American lobster. However, conventional methods do not sample this habitat effectively. Cobble-filled bio-collectors were developed to monitor settlement of American lobster in cobble habitat, but are colonized by a wide variety of invertebrates and fishes. We have a 10-year dataset of decapod crustacean and fish abundance (and for some years, data for all invertebrates; >500 species detected) from bio-collectors deployed in the southwest Bay of Fundy, which is considered a biodiversity hotspot and is among the fastest warming regions globally. We will

present multivariate analyses of decapod and fish assemblages, which suggest that overall assemblages have remained similar over the last decade. We will also examine trends in individual species over this time period. Our dataset provides the first record (2012) of juvenile cunner *Tautogolabrus adspersus* in this region and recent research motivated by this finding suggests the species is undergoing range expansion driven by increasing water temperature during embryo development. Our dataset demonstrates that cobble-filled bio-collectors are a useful tool to detect changes in biodiversity in shallow cobble habitat in response to anthropogenic impacts.

Microplastic Concentrations in the Intertidal Sediment and Benthic Organisms in the Lower Bay of Fundy, Southwestern New Brunswick

Krista L. **Beardy**[1] and Heather L. Hunt[2]
[1] *Huntsman Marine Science Centre, St. Andrews, NB (krista.beardy@huntsmanmarine.ca)*
[2] *University of New Brunswick, Saint John, NB (hhunt@unb.ca)*

Microplastics are a contaminant of emerging concern that originate from the breakdown of plastic debris (consumer and industrial) which is regularly introduced into the marine environment. As plastics breakdown, they are distributed throughout the marine environment and can accumulate in marine sediments where they can release potentially hazardous additives (i.e., bisphenol A, phthalates). Microplastics can also adsorb previously existing persistent organic pollutants which can bioaccumulate through the marine food web. In southwestern New Brunswick Bay of Fundy region, rates of plastic degradation may be influenced by extreme tides and long sun exposure during low tide, potentially leading to increased microplastic production (<5 mm) in intertidal sediments. Microplastic accumulation can increase marine wildlife mortality and reduce availability of suitable coastal habitat. This study quantifies regional microplastic distribution in intertidal marine sediments and, through the assessment of concentrations of microplastics in bivalve tissues, examines the potential impact of microplastics on benthic communities. Biological uptake is assessed using two species of bivalve, *Mya arenaria* (soft-shelled clam, filter feeder) and *Limecola balthica* (macoma clam, deposit/sediment feeder). Microplastic concentrations in sediments and bivalves are determined through density separation of microplastics followed by microscopic quantification. Data analysis will assess the relationship between concentrations in sediment and in sediment-dwelling clams.

Metadata for Bay of Fundy Long-term Hydrographic Monitoring Stations

Frederick J. **Fife**, Frederick H. Page and Blythe D. Chang
Fisheries and Oceans Canada, St. Andrews Biological Station, St. Andrews, NB (jack.fife@dfo-mpo.gc.ca)

Stations Prince 5 and Prince 6 are located in the Bay of Fundy and in the St. Croix River estuary respectively. Seawater temperature at the surface and at different depths down to near bottom has been measured and recorded at regular intervals at these two monitoring stations for more than 100 years by St. Andrews Biological Station staff.

The precision of these data must be determined before use in climate studies. There were many different instruments used over the years. We now have to verify that measuring devices used have been properly catalogued and calibrated. This information must be included with the data as metadata. The aim is to convey to future users “all details about study context, data collection, quality control and assurance as well as analytical procedures from the beginning of a research project and then including this descriptive

information in the metadata" (Kervin et al. 2013). This metadata file is being prepared following the *Ecological Archives* metadata content standard which is based on the format described in Michener et al. (1997). "Information about sampling designs, research methods, and identification of project personnel is central to interpreting and using data."

SESSION: OCEANS PROTECTION PLAN & MARINE PROTECTED AREAS

Oceans Protection Plan: Overview and Introduction

Phoebe **Miles**
Community Engagement and Partnerships, Transport Canada, Ottawa, ON (phoebe.miles@tc.gc.ca)

The Oceans Protection Plan highlights the Government of Canada's new direction on marine safety and shipping. The Government is investing $1.5 billion in the Oceans Protection Plan, a national strategy to create a world-leading marine safety system that provides economic opportunities for Canadians today, while protecting coastlines for future generations. It will focus on four priority areas:

- A world-leading marine safety system, which will improve how we prevent and respond to marine incidents;
- Protecting the marine environment by preserving and restoring marine ecosystems;
- Strengthening Indigenous partnerships; and
- Investing in science and local knowledge to produce a stronger evidence base.

The implementation of the Oceans Protection Plan will involve a whole-of-government strategy led by four federal departments. The Oceans Protection Plan places a strong emphasis on working collaboratively with marine stakeholders, along with forming new partnerships with Indigenous groups and other coastal communities.

The session will include an overview presentation of the Oceans Protection Plan led by Transport Canada with a focus on engagement and collaboration activities in the Atlantic region.

Piloting a Risk-based Response Planning Approach

Angela **Sangster**
Canadian Coast Guard, NB

In 2013, Transport Canada's Tanker Safety Expert Panel made a number of recommendations aimed at strengthening Canada's Marine Oil Spill Preparedness and Response Regime including the implementation of a regional, risk-based approach to environmental response planning for oil spills. In response to these recommendations, the Area Response Planning initiative was launched in 2014. The Area Response Planning pilot projects concluded in summer 2017. Lessons learned from the Area Response Planning initiative will inform the development of the Regional Response Planning pilot project for northern British Columbia, an Oceans Protection Plan initiative that was launched in 2017. The Regional Response Planning pilot project in northern B.C. will develop a risk-based approach to environmental response preparedness that is tailored to the unique conditions, risks and sensitivities specific to the area.

The scope of the Regional Response Planning is broader than that of the previous Area Response Planning initiative. It will look at additional hazards and sources of marine pollution, including vessels of all sizes; involve greater collaboration and engagement with Indigenous Peoples and coastal communities; and aim to be better integrated with existing marine planning and management mechanisms including planning frameworks at international, national, provincial, regional and local levels.

As planning efforts get underway in northern British Columbia, work done as part of the Regional Response Planning pilot as well as the Area Response Planning will be reviewed and, where applicable, will inform the development of a more collaborative environmental response planning approach for marine spills in Canada.

The Aboriginal Use of Marine and Coastal Resources in the Bay of Fundy, Canada

Jessica R. **Seward**[1] and J. Knill[2]
[1]*Maritime Aboriginal Peoples Council, Truro, NS (jseward@mapcorg.ca)*
[2]*Maritime Aboriginal Peoples Council, Truro, NS (jknill@mapcorg.ca)*

During 2015-16 and 2016-17 fiscal years, the Government led by Transport Canada committed to working collaboratively with key marine stakeholders to develop and implement tailored Area Response Plans (ARP) in four coastal areas nationally that have the highest level of tanker traffic. Two of these coastal areas were located in Fisheries and Oceans Canada (DFO) Maritimes Region: Saint John/Bay of Fundy, New Brunswick, and Port Hawkesbury/Strait of Canso, Nova Scotia.

During the first phase of this work the Maritime Aboriginal Peoples Council and Maritime Aboriginal Aquatic Resources Secretariate (MAPC-MAARS) collected Aboriginal Traditional Knowledge regarding the off-reserve Aboriginal Community's use of marine and coastal resources throughout the pilot project areas. DFO wishes to continue this work during the next phase of the project where MAPC-MAARS will continue the collection of similar information for the remaining Nova Scotia coastline excluding the previous year's pilot project areas as well as the Northumberland Strait/western Cape Breton.
Participants in the 'Aboriginal Peoples Use of Aquatic & Coastal Resources Study' provide vital information to the ARP Initiative, now the Regional Response Plan (RRP). This information will be used to Canada's Oil Spill Response Regime by identifying the risks specific to a geographic area in order to quickly and effectively limit the environmental, cultural and socio-economic impacts of a spill, including its liability and compensation component.

This presentation will focus on the Bay of Fundy, highlighting the information collected and the concerns and views raised by the Aboriginal community regarding oil spill response in the Bay of Fundy and throughout the Maritimes region.

Fisheries and Oceans Canada's Renewed Marine Environmental Quality Program

Heather **Breeze**[1]
[1]*Oceans and Coastal Management Division, Fisheries and Oceans Canada, Dartmouth, NS (heather.breeze@dfo-mpo.gc.ca)*

Under Canada's Oceans Protection Plan, Fisheries and Oceans Canada received funding to reinvigorate its marine environmental quality (MEQ) program. The aim is to increase understanding of and address pressing issues affecting the quality of the marine environment. In related initiatives, DFO is also

increasing its work on marine stressors, cumulative effects and baseline data. Over the next few years, the MEQ program will focus on issues affecting marine mammals, including noise. While marine mammals and noise is the short-term focus, the long-term goal is to create a comprehensive environmental quality program that provides the necessary information as well as the regulatory and non-regulatory tools to maintain all aspects of healthy marine, coastal and estuarine ecosystems. As responsibilities for managing activities in the marine environment are shared, maintaining healthy ecosystems cannot solely be accomplished by DFO efforts. To be successful, the MEQ program seeks to collaborate with other regulators, industry, Indigenous groups, non-government organizations and community groups. The presentation will highlight efforts underway to better understand the soundscape in the Bay of Fundy-Scotian Shelf bioregion, as well as other activities related to key MEQ issues.

Oceans Protection Plan: Cumulative Effects of Marine Shipping

Paula **Doucette**
Transport Canada, Vancouver, BC (paula.doucette@tc.gc.ca)

As part of the Oceans Protection Plan, the Government of Canada will establish a shared approach to better understand coastal ecosystems and the potential effects of regional marine vessel activity on the environment. Transport Canada's Cumulative Effects of Marine Shipping Initiative seeks to create a cumulative effects assessment framework that would focus on 6 coastal sites across Canada including an area within the Bay of Fundy. Local communities, stakeholders and Indigenous Nations will be engaged to determine key concerns and help collect baseline information that can be used to inform assessments of the cumulative effects of marine shipping framework and identify specific mitigation tools that can be applied to existing and future vessel movements.

This presentation will provide an overview of the cumulative effects of marine shipping initiative, engagement and collaboration activities, timelines of the initiative, desired outcomes, and next steps.

Strengthening Relationships through Coastal Environmental Baseline Data Collection: A Case Study in the Port of Saint John, New Brunswick

Graham **Bartlett[1],** Rachel Long[2], Claire Mussells[3], Stacey Paul[4] and Mike Sullivan[5]
[1] *Fisheries and Oceans Canada, St Andrews, NB (graham.bartlett@dfo-mpo.gc.ca)*
[2] *Fisheries and Oceans Canada, St Andrews, NB (rachel.long@dfo-mpo.gc.ca)*
[3] *Fisheries and Oceans Canada, St Andrews, NB (claire.mussells@dfo-mpo.gc.ca)*
[4] *Fisheries and Oceans Canada, St Andrews, NB (stacey.paul@dfo-mpo.gc.ca)*
[5] *Fisheries and Oceans Canada, St Andrews, NB (mike.sullivan@dfo-mpo.gc.ca)*

Ecosystem characterization and evidence-based decision making are crucial to the effective management and preservation of marine ecosystems in Canada's busiest and most industrial ports. The collection of comprehensive baseline data, will provide a snapshot in time, and allow for better detect of changes in the environment. Over the next four years, the Coastal Environmental Baseline program, an initiative under Canada's Ocean Protection Plan, will be piloted in six sites across Canada, the Port of Saint John being one of the pilots. The Port of Saint John is located in the Bay of Fundy and is home to industries such as fisheries, aquaculture, oil and gas, mining and ecotourism. Fisheries and Oceans Canada is working with local Indigenous and stakeholder groups to collaboratively identify key ecosystem components and study site boundaries; compile current and historical environmental datasets to identify outstanding data needs; prioritize, plan and carry out data collection; as well as data management and visualization. The datasets will be available to participating groups as well as Fisheries and Oceans Canada and other federal

departments to inform management decisions in areas such as fisheries management, species at risk, environmental impact assessments and Transport Canada's Cumulative Effects of Shipping program. This program sets out to strengthen relationships with local Indigenous and stakeholder groups by helping to increase local capacity to collect ecological, social and culturally important ecosystem indicators to better reflect their needs in decision making and to allow for changes in the environment to be better detected over time.

Marine Protected Area Network Development in the Scotian Shelf Bioregion: Progress to Date

Elise **Will**, Marty King, Tanya Koropatnick, Maxine Westhead, Derek Fenton, Gary Pardy
Fisheries and Oceans Canada, Bedford Institute of Oceanography, Dartmouth, NS (elise.will@dfo-mpo.gc.ca)

In the past two years, Canada has significantly increased its percentage of marine protection from less than 1% to over 7% nationally. This has largely been driven by Canada's commitment to achieving Aichi Target 11 (under the Convention on Biological Diversity) of 10% protection by the year 2020. An important part of this process has been the development of marine protected area (MPA) network plans within five of Canada's 13 aquatic bioregions. This work has been ongoing in the Scotian Shelf Bioregion, which includes the Bay of Fundy, Gulf of Maine, the Scotian Shelf, and deeper waters of the abyssal plain. An MPA network plan for the Scotian Shelf Bioregion will ultimately guide the establishment of new MPAs in the region over the long term.

As an intermediate step, a draft MPA network design for the Scotian Shelf Bioregion will soon be released for consultation. A brief overview of the steps taken to develop the draft MPA network design will be presented. This will include an overview of the key ecological and socioeconomic data inputs, the method for selecting candidate sites in both the offshore and along the coast/in the Bay of Fundy, and the approach used to minimize potential socioeconomic impacts. Finally, more information will be provided on the next steps to reach a final MPA network plan for the Scotian Shelf Bioregion.

SESSION: DYKELANDS AND TIDAL WETLAND RESTORATION (Friday)

The Impact of Flood and Erosion Prevention Structures and Strategies on Saltmarsh Development in the Cobequid Bay, Nova Scotia

Graeme A. **Matheson**[1], Danika van Proosdij[2] and Christopher Ross[3]
[1] *Saint Mary's University, Halifax, NS (matheson.ga@gmail.com)*
[2] *Department of Geography and Environmental Studies, Saint Mary's University, Halifax, NS (dvanproo@smu.ca)*
[3] *Maritime Provinces Spatial Analysis Research Center, Saint Mary's University, Halifax, NS (christopher.ross@smu.ca)*

Flood and erosion prevention structures and strategies (e.g., dykes, borrow pits) are often implemented in anthropogenically modified coastal regions to protect against coastal hazards. If saltmarshes are to be incorporated into a coastal management plan as a source of coastal defence it is paramount to understand how ecomorphodynamic feedbacks triggered by implementing flood prevention structures and strategies can impact saltmarshes. This study examines how these structures in combination with natural drivers have precipitated changes in foreshore saltmarsh erosion and progradation rates over varying spatial scales in the hypertidal Cobequid Bay, during the past 80 years. Foreshore change rates were obtained

using a geographical information system (GIS), as well as imagery and digital surface models (DSMs) derived from an unmanned aerial vehicle (UAV). Furthermore, UAV DSMs were used to determine short-term sediment budgets in saltmarsh borrow pits. Natural cyclical foreshore change rates were observed in the Cobequid Bay, but are often augmented by the presence of anthropogenic structures. Erosion and progradation rates in individual transects have been observed to be as much as -14.9m/year and 20.1 m/year, respectively. Furthermore, results suggest that under specific environmental conditions some structures work in tandem with saltmarshes to protect the upland by precipitating ecomorphodynamic feedbacks that promote saltmarsh progradation. Conversely, other structures can exacerbate natural cycles of erosion, locally. Borrow pit studies reveal that although local suspended sediment concentrations, which can vary from 50mg/l to 50000mg/l, play an integral role in pit sedimentation, channel geometry design may play an equally important role in governing infill rates.

Dynamics of Focal Plant Patches during a Salt Marsh Restoration in the Upper Bay of Fundy from 2011–2017

Gregory S. **Norris**, Spencer D.S. Virgin and Myriam A. Barbeau
University of New Brunswick, Fredericton, NB (gnorris1@unb.ca, svirgin@unb.ca, mbarbeau@unb.ca)

Salt marshes are vital, highly productive ecosystems, characterized by halophytic vascular plants that have successfully colonized soft sediments in the high intertidal zone. In recent years, there has been much interest in restoring salt marshes. Since 2011, in a salt marsh restoration project in Aulac, New Brunswick, we monitored vegetation dynamics in "patches" in two previously diked terrestrial cells (i.e., sites being restored), as well as in two adjacent reference salt marshes. Specifically, we quantified stem density and status (live, dead, flowering) and plant height, as well as conducted year-specific investigations into soil salinity, root biomass, and "patch" connectivity. After the old dikes were breached, *Spartina pectinata* (freshwater cordgrass), which was present on-site prior to breaching, survived and spread from 2011 to 2013, although it showed stunted growth. From 2013 to 2015, we observed the decline and eventual disappearance of *S. pectinata* from the restoration sites. The primary ecosystem engineer of salt marshes, *Spartina alterniflora* (saltwater cordgrass), appeared in 2012, displayed the tall form phenotype, vigorously spread vegetatively (by rhizomes), and then starting in 2014 spread sexually (by seeds), until it formed a dense cover throughout each restoration site. Upon comparing established and seedling "patches" of *S. alterniflora*, we found that seedlings take 2 years to become established and start reproducing vegetatively and to flower. Currently, in addition to growing along the dikes, there are two "patches" of *Spartina patens* (salt marsh hay) located within one of the restoration site, forecasting the expected future change in plant community. We plan to continue to monitor the "patch" dynamics of plants in Aulac and use our detailed observations to model the colonization and spread of salt marsh plants during restoration in the upper Bay of Fundy.

Community Dynamics in a Salt Marsh Restoration Project in the Upper Bay of Fundy: Seven Years Later

Spencer D.S. **Virgin**[1], Jeff Ollerhead[2], Myriam A. Barbeau[1] and Nic R. McLellan[3]
[1]*University of New Brunswick, Fredericton, NB (svirgin@unb.ca, mbarbeau@unb.ca)*
[2]*Mount Allison University, Sackville, NB (jollerhead@mta.ca)*
[3]*Ducks Unlimited Canada, Amherst, NS (n_mclellan@ducks.ca)*

Salt marshes are highly productive ecosystems characterized by salt tolerant plants that have colonized soft sediment areas in the high intertidal zone. Due to the high fertility of salt marsh soil, many salt

marshes were converted to agricultural land over the past three centuries. Given the many ecosystem services we now know are provided by salt marshes, there is considerable interest in reverting diked farmland back to salt marsh. Managed realignment, where a new dike is built upland and a salt marsh is encouraged to develop in front of it, is currently a popular coastal management strategy, and is being used and tested in our project. Our salt marsh restoration project started in 2009–2010 in Aulac, NB; two adjacent cells of farmland were opened to sea water by manually breaching the old dikes. Each summer, we revisit and quantify the emergent plant and invertebrate communities of these restoration sites and 2 adjacent natural sites (i.e., reference salt marshes). The restoration is currently at a critical phase where (i) the salt marsh foundational grass species, *Spartina alterniflora*, has established itself and spread throughout the restoration sites and (ii) the old dikes have eroded away leaving the young marshes exposed to the full force of erosion. Very encouragingly, the restoration salt marshes are continuing to accumulate sediment at high rates, possibly due to increased plant cover. This study provides a valuable opportunity to study the long term restoration dynamics of salt marshes in the upper Bay of Fundy.

Living Shorelines in Atlantic Canada: Effectiveness of Natural Bank Protection

Kirsten **Ellis**[1], Jeremy Lundholm[2] and Rosmarie Lohnes[3]
[1] *CBWES Inc., Halifax, NS (kirstenellis77@gmail.com)*
[2] *Saint Mary's University, Halifax, NS (jeremy.lundholm@smu.ca)*
[3] *Helping Nature Heal Inc., Bridgewater, NS (rosmarie@helpingnatureheal.com)*

Living shorelines encompass a broad spectrum of nature-based techniques used to manage coastal challenges such as erosion, flooding, habitat loss, and water quality. Living shorelines are an alternative to hard shoreline protection structures, like bulkheads and stone armouring. These alternatives are gaining increasing attention as the negative effects of shoreline hardening, such as loss of beaches, decreased accessibility, increasing costs and degradation of nearshore habitat, are becoming more prevalent as the amount of hardened shorelines, and our understanding of the impacts, steadily increases. Globally, living shoreline research is showing promising results for erosion reduction, storm protection, and habitat restoration in a wide variety of coastal environments. In Atlantic Canada, awareness and popularity of living shoreline concepts has been growing, primarily among coastal landowners. The research presented here investigated the effectiveness of three, locally developed techniques that are currently being used in NS and PEI to reduce erosion on coastal banks. The combination of mulching with hay, weaving brush, and planting native species has been shown to be effective in reducing erosion and encouraging revegetation on many of the coastal properties where it's been tested. The results of this recent study confirm that erosion rates from sub aerial processes and upland factors can be significantly reduced using this combination of techniques. This represents the first experimental investigation into this kind of nature-based erosion management in Nova Scotia. The positive results will hopefully lead to an increased awareness and application of living shoreline concepts in coastal management in Atlantic Canada.

Modeling Present-Day and Future High Water Lines with Lidar, Surveyed Dykes, and Modeled Water Crossings, and its Impact on Dykelands

Raymond **Jahncke**[1], Danika van Proosdij[2] and Christopher Ross[3]
[1] *Saint Mary's University, Halifax, NS (raymond.jahncke@smu.ca)*
[2] *Department of Geography and Environmental Studies, Saint Mary's University, Halifax, NS (dvanproo@smu.ca)*
[3] *Maritime Provinces Spatial Analysis Research Center, Saint Mary's University, Halifax, NS (christopher.ross@smu.ca)*

French settlers began constructing dykelands in Nova Scotia in the 18th century to expand on available areas to grow hay. Today, the responsibility of maintaining the dyke infrastructure lies with the provincial government with landowners responsible for the land itself. The dykes and the land are susceptible to damage over time but changing conditions necessitate a review of the present High Water Line (HWL) for every dykeland in Nova Scotia. As part of the National Disaster Mitigation Program, we are investigating boundaries (demarcated since the 1950's) of existing dykelands in Nova Scotia that are designated to a Marsh Body. Using the present day HWL elevation, existing boundaries will be compared to boundaries delineated with lidar digital elevation models and surveyed elevations. We have developed a procedure to model concealed water crossings to connect flood zones that would otherwise appear isolated. The maps from this project will show cases where the dykes and/or surrounding upland is below the present-day HWL, and can be used to assist managers to assess risk and make better informed decisions on dyke elevation, aboiteau size, etc.. These maps will also be important for owners of infrastructure (e.g., buildings and roads) that would be affected by flooding. In addition, future implications of sea level rise sets in motion conditions that will require further consideration of adjusting Marsh Body boundaries in most cases. We have applied the same methodology to show future HWLs, while highlighting the risk to infrastructure if steps are not taken to prepare for changing conditions.

POSTERS

INFORMATION USE AT THE SCIENCE-POLICY INTERFACE IN DECISION-MAKING INN THE BAY OF FUNDY REGION

Sharing Victories: Enablers and Barriers to Collaborative Relationships within the Conservation Sector

Rachael **Cadman**[1], Bertrum H. MacDonald[2] and Suzuette S. Soomai[2]
[1] *School for Resource and Environmental Studies, Dalhousie University, Halifax, NS*
[2] *School of Information Management, Dalhousie University, Halifax, NS (r.cadman@dal.ca, bertrum.macdonald@dal.ca, suzuette.soomai@dal.ca)*

At the 10th Conference of Parties to the UN Convention on Biological Diversity in 2010, Canada committed to protecting 10% of Canada's territorial ocean by the year 2020. When the federal government recommitted to that goal in 2015, it also set an interim goal of protecting 5% by the end of 2017. Shortly after the election in 2015, the government convened a meeting for Environmental Non-Government Organizations (eNGOs) to enlist their help in achieving these targets. By engaging with eNGOs to solicit their assistance with the 2020 targets, the federal government encouraged their active participation in the decision-making process. Since 2015, eNGOs have been engaged in gathering and distilling information to advise policy makers on the creation of marine protected areas (MPAs) in Canada's coastal and marine environment.

In this more inclusive environment, many Canadian eNGOs have chosen to work collaboratively to promote a unified message. A case study of two eNGOs: World Wildlife Fund Canada (WWF), and the Ecology Action Centre (EAC), examined the nature of those formal and informal collaborative relationships, and the enablers and barriers to successful partnerships between organizations. This poster presents key findings from the study focused on the efforts of WWF and EAC on the design and implementation of three MPAs and makes recommendations for effective collaborative work within the Atlantic eNGO community.

Global Resource, Local Needs: A Case Study of the Use of the International Aquatic Sciences and Fisheries Abstracts Database

Diana **Castillo**, Bertrum H. MacDonald and Suzuette S. Soomai
School of Information Management, Dalhousie University, Halifax, NS (diana.castillo@dal.ca, bertrum.macdonald@dal.ca, susuette.soomai@dal.ca)

A significant hallmark of today's society is the large quantity of scientific information about marine environments available to researchers and decision-makers in a wide diversity of formats. Although much information is easily accessible, sizeable volumes may be unknown or limited in access despite their benefit for stakeholder communities. The Aquatic Sciences and Fisheries Abstracts (ASFA) database has been a global resource since 1971 on the science, technology, and management of marine, brackish water, and freshwater environments, and is an access point for a large number of grey literature publications. Currently, ASFA contains over two million records, of which over 3,000 relate to the Bay of Fundy.

Due to the rapidly changing information landscape today, the future of ASFA in its present form is being reconsidered. Does an abstracting and indexing service have a place in present day marine research and ocean and coastal management? Does ASFA meet the information needs of its potential users or are alternatives available that are equally or better-suited to users? This poster will report on research, pursued in collaboration with the Food and Agriculture Organization of the UN, to determine how ASFA is currently accessed and used. This poster will show how a resource with a global reach relates to the Bay of Fundy and outline the impact changes in the service may have for researchers and others in the region.

The Important Role of Technical Working Groups in Evidence-Based Decision-Making for Marine Fisheries Management

Kalene L. **Eck**[1], Suzuette S. Soomai[2] and Bertrum H. MacDonald[2]
[1] *Marine Affairs Program, Dalhousie University, Halifax, NS (kalene.eck@dal.ca)*
[2] *School of Information Management, Dalhousie University, Halifax, NS (suzuette.soomai@dal.ca, bertrum.macdonald@dal.ca)*

The use of scientific information for evidence-based decision-making is a critical component of integrated coastal and ocean management. However, ensuring that the "right" information is available for addressing these issues can be a challenge as this information often resides in different organizations with different management mandates. Consequently, marine management organizations addressing complex issues have utilized a range of approaches, including technical advisory committees and working groups, to promote the development of robust solutions and recommendations for integrated management. This poster presents the results of a case study that examined the role of technical working groups in fisheries management in Belize. These working groups include representatives of government and non-governmental organizations, academic institutions, and the fisheries sector. Based on interviews of members of three working groups and decision-makers in the Belize Fisheries Department, information production and communication processes, and how information products are used were determined. Characteristics of the science-policy interface in fisheries management, including common enablers and barriers related to knowledge exchange were identified. Technical working groups play an extremely important role as boundary agents that bridge the communication of information between scientific and policy-making groups. Criteria for evaluating the effectiveness of working group strategies in facilitating evidence-based decision-making were developed based on the identified enablers to production,

communication, and use of information. The results of this study can inform organizations using similar working group strategies to enhance stakeholder collaboration and to produce credible, relevant, and salient information for integrated coastal and ocean management in the Bay of Fundy region.

Examining Socioecological Ocean Connections in a Coastal Community: Implications for Local Policy and Science Communication

Simon R. **Ryder-Burbidge**[1], Bertrum H. MacDonald[2] and Suzuette S. Soomai[2]
[1] *Marine Affairs Program, Dalhousie University, Halifax, NS (s.ryder-burbidge@dal.ca)*
[2] *School of Information Management, Dalhousie University, Halifax, NS (bertrum.macdonald@dal.ca, suzuette.soomai@dal.ca)*

Engaging the public in the development of policy is recognized as an integral element of coastal governance today. The coast is a very complex socioecological setting in which a variety of interests often compete for resources and space. To effectively manage shared coastal areas, decision-makers must first understand how coastal residents value the coastal zone. A 2017 survey conducted in Falmouth, Massachusetts uncovered perceived "connections" expressed by coastal residents for the marine environment and identified their preferred coastal policy adaptations. The results show 1) uncertainty related to the safety of the community regarding flood risk, 2) a strong belief in the protection of wetland and coastal habitats, 3) a call to limit human-made coastal structures and restore natural barriers, and 4) a desire for interaction between local scientists and citizens, and more accessible ocean science. This poster provides recommendations for policymakers in coastal communities to incorporate public perceptions and community input into communication and planning efforts.

Characteristics of the Science-Policy Interface: Scientific Information Use in Coastal and Ocean Decision-Making

Suzuette S. **Soomai**[1], Bertrum H. MacDonald[1], James D. Ross[2], Peter G. Wells[3] and Lee Wilson[4]
[1] *School of Information Management, Dalhousie University, Halifax, NS (suzuette.soomai@dal.ca, bertrum.macdonald@dal.ca)*
[2] *Faculty of Engineering, Dalhousie University, Halifax, NS (rossjd@dal.ca)*
[3] *School of Information Management, Marine Affairs Program, and International Ocean Institute-Canada, Dalhousie University, Halifax, NS (oceans2@ns.sympatico.ca)*
[4] *Portage/ACENET, Canadian Association of Research Libraries, Halifax, NS (lee.wilson@ace-net.ca)*

Understanding how scientific information is communicated and used at the science-policy interface is fundamental for strengthening policy- and decision-making processes designed to provide solutions for ongoing serious coastal and ocean problems. For over a decade, the interdisciplinary Environmental Information: Use and Influence research program at Dalhousie University has been conducting research, in collaboration with national, regional, and international governmental and non-governmental organizations, that provides empirical evidence to characterize the interface. Drawing on the results of this research, this poster describes major enablers and barriers that affect the update of scientific information in decision-making. Case studies on the use of state of the environment reports, technical assessments, and coastal atlases; studies on communication in multi-sector networks; and studies on decision-making processes within governmental organizations identified the enablers and barriers. A suite of quantitative and qualitative methods (e.g., citation analysis; content and discourse analysis; interviews of researchers, decision makers and other stakeholders; observations of meetings at local, regional, and international levels; and network analysis) were used to build an understanding of the interactions at the

science-policy interface. This research shows that multi-stakeholder partnerships involving government and non-governmental organizations, academic institutions, industry, and the public facilitate the production of credible, relevant, and legitimate information for decision-making. Furthermore, the uptake of such "useable" information is often influenced by organizational processes, the bridging roles of particular actors, and the formats of information products. Nonetheless, awareness remains a major barrier for effective communication and use of information in coastal and ocean management. This understanding of the science-policy interface can guide individuals and groups in the Bay of Fundy region to pursue appropriate roles in policy-making processes, thereby promoting good coastal and ocean governance.

DYKELANDS AND TIDAL WETLANDS RESTORATION

Looking Back over Twelve+ Years of Tidal Wetland Restoration Projects in Nova Scotia, Canada

Tony M. **Bowron**[1], Jennie M. Graham[1], Danika van Proosdij[2], Jeremy Lundholm[3], Nancy C. Neatt[1] and Robert Pett[4]
[1] *CBWES Inc., Halifax, NS (tony.bowron@cbwes.com)*
[2] *Department of Geography and Environmental Studies, Saint Mary's University, Halifax, NS (dvanproo@smu.ca)*
[3] *Department of Biology, Saint Mary's University, Halifax, NS (jeremy.lundholm@smu.ca)*
[4] *Nova Scotia Department of Transportation and Infrastructure Renewal, Halifax, NS (bob.pett@novascotia.ca)*

Tidal wetlands play a key role in our environment, particularly in the face of the increasing risks associated with climate change and rising sea levels. Conservative estimates for Nova Scotia (NS) put the loss of tidal wetland habitat at greater than 50% province wide, and that number jumps to approximately 80% for the Bay of Fundy, mostly associated with dyking and conversion to agricultural land. Although these activities are of historical and social significance, it is now recognized that the large scale loss of habitat, species and primary productivity that has resulted from the construction of dykes, modern tidal barriers (causeways), and coastal development have had considerable adverse ecological impacts. Since 2005, efforts have been made to mitigate the loss of tidal wetland habitat in Nova Scotia. During that time over a dozen tidal wetland projects, complete with comprehensive long-term ecological monitoring programs have been undertaken. These projects have ranged from replacing tidally restrictive culverts (i.e., Cheverie Creek), to the breaching of agricultural or impoundment dykes (i.e., Walton River) and allowing for passive restoration of wetland species and function, to the inclusion of more active restoration efforts such as the design and construction of tidal channels and pannes (i.e., St. Croix). This poster will provide a look back over twelve years of tidal wetland restoration projects in NS highlighting successes in the field, advancements in restoration design, lessons learned, and a look forward to what the next decade may hold for tidal wetland restoration in the region.

High Resolution, Low-Altitude Aerial Photography for Habitat Restoration, Monitoring and Mapping

Jennie M. **Graham**[1], Tony Bowron[1], N.C. Neatt[1], Danika van Proosdij[2] and Greg Baker[2]
[1] *CBWES Inc., Halifax, NS (tony.bowron@cbwes.com)*
[2] *Department of Geography and Environmental Studies, Saint Mary's University, Halifax, NS (dvanproo@smu.ca)*
[3] *Maritime Provinces Spatial Analysis Research Center, Saint Mary's University, Halifax, NS (greg.baker@smu.ca)*

One of the technologies that we have used over the past eight years to design and monitor coastal habitat restoration projects has been low-altitude aerial photography. For example, our use of helium balloon and drone-based camera systems to produce high resolution digital imagery which enables us to track changes in landscape level morphological conditions and vegetative re-colonization at a fraction of the time, effort and cost of traditional monitoring methods or aerial photography. The use of this technology continues to enhance our ability monitor habitat conditions, is less intrusive and enables us to produce a high quality product at an affordable rate. As the technology evolves, so does the range of scientific and management applications in which it is making a positive impact. This poster explores a few of the primary and derived products that are being used to benefit restoration and research efforts, and to aid public and private decision-makers.

Maximizing Adaptive Capacity and Ecosystem Services: A GIS-based Approach to Managed Realignment

Jennie M. **Graham**[1], Tony Bowron[1], Nancy C. Neatt[1] and Dankia van Proosdij[2]
[1] *CBWES Inc., Halifax, NS (tony.bowron@cbwes.com)*
[2] *Department of Geography and Environmental Studies, Saint Mary's University, Halifax, NS (dvanproo@smu.ca)*

Dykes and adjacent marshlands are of strategic importance for climate change adaptation as they provide the first line of defense for many coastal communities from storm surge, sea level rise and erosion hazards. Managed realignment within the Bay of Fundy region has been identified as a viable adaptation method to current and future risks associated with climate change. However, limited information exists about how to evaluate and prioritize appropriate sites. A GIS multi-criteria assessment framework was developed to provide a coarse prioritization of potential candidate sites for realignment in key estuaries within the region. A realignment score was calculated based on composite scores in the categories of ecosystem services (e.g., morphology, habitat quality, hydrology, biomass, connectivity) and adaptive capacity (e.g., accommodation space, dyke length, foreshore, width) less cost (e.g., infrastructure, dyke condition). A total of 64 cells, which were made up of 60 regulated marsh bodies, were classified into three classes of suitability. Seventeen percent of the marsh bodies analyzed were found to be unsuitable for realignment while forty two percent were found to be suitable. Forty-one percent were classified as proceed with caution. The framework developed offers advantages moving forward as the matrix format allows for the addition of new sites and the adjustment of weights and ranking scales in response to both new data and new questions.

An Analysis of Multispectral UAS for Salt Marsh Foreshore Land Cover Classification and DEM Generation

Logan **Horrocks**[1], Greg Baker[2] and Danika van Proosdij[1]

[1]*Department of Geography and Environmental Studies, Saint Mary's University, Halifax, NS (logan.horrocks@smu.ca)*
[2]*Maritime Provinces Spatial Analysis Research Center, Saint Mary's University, Halifax, NS*

Recent advances in Unmanned Aerial Systems (UAS), and increased affordability have proliferated their use in the scientific community. Despite these innovations, UAS attempts to map a site's true elevation are obstructed by vegetative canopies; resulting in the production of a Digital Surface Model (DSM),

rather than the intended Digital Elevation Model (DEM). This project seeks to account for the varying heights of vegetation communities within the Masstown east saltmarsh, producing DEMs for mudflat/saltmarsh landscapes with an accuracy comparable to that the DSM. DEM generation has been completed in two separate stages. The first stage consists of land cover classifications using UAS derived, radiometrically corrected data. Respective land cover classifications are assessed using confusion matrices. Secondly, surveyed canopy heights and function derived heights are subtracted from their respective classes, generating the DEMs. DEM validation has been performed by comparing topographic survey point values to those modeled, using the Root Square Mean Error (RMSE) measure. The project then compares the various parameters implemented for land cover classifications, and DEM accuracy. DEM generation methods were then coupled to produce a final DEM with a RSME of 6 cm. The results suggest consumer grade Multispectral UAS can produce DEMs with accuracies comparable to the initial DSMs generated, and thus merit further studies investigating their scientific capacities.

Rehabilitating and Restoring Unique Landscapes within Five Nova Scotia Watersheds along the Bay of Fundy, Nova Scotia, Canada

Jamie C.J. **Knill**[1] and Vanessa A. Mitchell[2]
[1] *Maritime Aboriginal Peoples Council, Truro, NS (jknill@mapcorg.ca)*
[2] *Maritime Aboriginal Peoples Council, Truro, NS (vmitchell@mapcorg.ca)*

The watersheds of the inner Bay of Fundy are important both ecologically and culturally. They are critical habitat for the endangered inner Bay of Fundy (iBoF) Atlantic Salmon (*Salmo salar*) and were significant cultural and harvesting sites for our land's first inhabitants, the Mi'kmaq People. Unfortunately, the watersheds have become degraded over time due to anthropogenic activities, leaving watercourses inaccessible or unsuitable for fish.

Our five year study will investigate and address areas of fish habitat concern in the Chiganois, Debert, Folly, Great Village, and Portapique Watersheds. Through reconnaissance and surveys, planning, engineering, physical labour, and community support, we will help to restore fish habitat by enhancing coastal entry points and removing obstructions from migration routes for iBoF Atlantic Salmon and other migratory fish. Additionally, our study will collect local community knowledge and Aboriginal Traditional Knowledge about watercourses in each watershed to determine changes in the anthropogenic and fish use of the watercourses. This information will be used to set restoration goals and inform the restoration planning process. We will also assess and propose innovative solutions for modification or replacement of the aboiteau on the Chiganois River in collaboration with project partners and community members.

The outcomes from this project will be 1) increased knowledge of the five watersheds and their use by both fish and humans presently and in the past; 2) a scientifically supported management plan for each watershed that prioritizes fish habitat restoration actions; 3) increased capacity of local communities to protect, monitor, and restore fish habitat.

Biotic Communities and Environmental Conditions of Salt Pools for an Ongoing Salt Marsh Restoration in the Bay of Fundy, New Brunswick, Canada

Heather B. **Reid**[1], Allen D. Beck[1], Myriam A. Barbeau[1] and Nic R. McLellan[2]
[1] *Department of Biology, University of New Brunswick, Fredericton, NB*
[2] *Ducks Unlimited Canada, Amherst, NS*

Salt marsh pools provide important habitat for wildlife (waterfowl, shorebirds and several species of fish) and thus are of interest in salt marsh restoration projects. Since 2010, one such marsh restoration project in Aulac, NB, in the upper Bay of Fundy (initiated by Ducks Unlimited Canada and partners) has been monitored annually to record the community succession of salt pool animals in minnow traps, invertebrate activity traps, and benthic grabs as well as changes in abiotic pool conditions (water salinity, pH, temperature, dissolved oxygen, flow). The project consists of two former farmland fields being restored to salt marsh after the breaching of agricultural dikes (restoration sites) and two adjacent established salt marshes used as reference sites (natural sites). The salt pools of the restoration sites remain different from the natural marsh pools as of 2017. They contain animal communities that more closely resemble mudflats or marsh creeks with annelid species, the amphipod *Corophium volutator*. as well as fewer fish. The abiotic conditions in the restoration sites' pools also show important differences, such as lower dissolved oxygen levels, and are more similar to conditions in the open bay than in the established salt pools in the natural sites. Measurements of water flow in the salt pools support this observation. Salt pool formation is poorly understood, and the results of this project indicate that it is a slow process. Future monitoring is necessary as development continues, especially because the recent dense growth of *Spartina alterniflora* around the pools may accelerate their stabilization and development.

Incorporating Climate Change Adaptation into the Aboiteau Upgrade Design for an Agricultural Marsh

Christopher **Ross**[1], Bryden Marinelli[2], Sascha Krizsan[3], Lauren Fleet[4] and Kevin Bekkers[5]
[1] *Dalhousie University, Halifax, NS (christopher.ross@dal.ca)*
[2] *Dalhousie University, Halifax, NS (bryden.marinelli@dal.ca)*
[3] *Dalhousie University, Halifax, NS (Krizsansascha@dal.ca)*
[4] *Dalhousie University, Halifax, NS (lauren.fleet@dal.ca)*
[5] *Nova Scotia Department of Agriculture, Truro, NS (kevin.bekkers@novascotia.ca)*

Aboiteaux, gated structures that provide a means of draining excess freshwater from agricultural land at low tide while preventing salt water infiltration at high tide, are crucial in ensuring minimal impacts of flooding upstream. Due to increased precipitation caused by climate change and the fact that many aboiteaux were built in the 1950's, there is a need for several structures to be upgraded and/or replaced. Our project focused on examining a high-priority aboiteau located in Highland Village, Nova Scotia, owned and maintained by the Nova Scotia Department of Agriculture. We have developed a procedure for determining the required structure capacity by incorporating climate change projections as well as a means for assessing hydraulic performance based on a variety of design configurations. A final recommended design solution was determined through evaluating each alternative by several factors (e.g., cost, serviceability, performance). This project provides a framework that can be adapted to aid in aboiteau upgrade/design and the results accentuate the importance of understanding and assessing climate change impacts on these drainage structures and the agricultural land they protect.

Ribbed Mussels (*Geukensia demissa*): An Important Ecosystem Engineer Conspicuously Absent from Salt Marshes in the Bay of Fundy

Spencer D.S. **Virgin** and Myriam A. Barbeau
University of New Brunswick, Fredericton, NB (svirgin@unb.ca, mbarbeau@unb.ca)

Ribbed mussels contribute to the productivity of salt marshes along the Atlantic coast of North America, from Florida to the Gulf of St. Lawrence. However, little is known about their population dynamics at their northern range limit, Maritime Canada. As a step in modelling ribbed mussel populations at their northern range limit, we quantified ribbed mussel density (# m^{-2}) and size (mm shell length) in 2 different microhabitat types (the exposed marsh edge and the marsh creeks) at 25 sites along the east coast of New Brunswick, 4 sites along the Bay of Fundy coast of New Brunswick, 11 sites along the Gulf Shore of Nova Scotia, and 10 sites along the coast of Maine. Ribbed mussels were not found in the Bay of Fundy, but were present along the southern coast of Maine (average ± SD: 1.8 ± 6.2 mussels m^{-2}). Density decreased to zero along the northern coast of Maine and in the Bay of Fundy, likely due to decreased temperatures, limiting larval development, and increased sediment loading, reducing filter feeding efficiency. Ribbed mussel densities were highest (120.7 ± 26.8 mussels m^{-2}) in the central Northumberland Strait, but varied substantially within and among sites and microhabitat types. Densities were close to zero between Bouctouche and Kouchibouguac National Park, likely due to low-amplitude and infrequent tides, increased along the Acadian Peninsula (8.9 ± 10.9 mussels m^{-2}), and decreased to zero in Chaleur Bay (northern New Brunswick), likely due to low salinities. This study provides the first demographic information for ribbed mussel populations in Maine and Maritime Canada and, as such, provides important baseline information to compare to potential future range shifts caused by climate change.

FISHERIES ECOLOGY & COASTAL MANAGEMENT

Tracking the Development of Individual American Lobster Embryos to More Accurately Predict Time of Hatch

Tammy (Sha) **Bo**[1], Erin Miller[1], Julien Gaudette[2] and Rémy Rochette[1]
[1] *University of New Brunswick, Saint John, NB (m4edq@unb.ca)*
[2] *Fisheries and Oceans Canada, Biological Station, St. Andrews, NB*

Connectivity among American lobster populations influences stock structure and recruitment dynamics, knowledge of which is important to the management of lobster fisheries. Models of connectivity via larval drift are, however, sensitive to variation in the timing of embryo hatch. In this study we raised ovigerous female lobsters (n=12) and individual embryos detached from the female (n=24/female) at ambient (7–13°C) and constant (8°C ±0.5°C) temperature, from May to August 2017, to increase our understanding of embryo development rate and stage at hatch. We used two potential indices of embryo development, the Perkins Eye Index (PEI) and a Yolk Index (YI). Every second week until all larvae had hatched, we measured PEI and YI of 24 randomly selected embryos removed from each female and of all 288 individually raised (detached) embryos. We will: i) compare development rate and stage at hatch of attached versus detached embryos; ii) quantify how intra- and inter-brood variability in development rate and stage at hatch affect the hatch period; iii) determine whether the PEI or YI provides the better metric of embryonic development; and iv) determine the extent to which our prediction of hatch time is improved by randomly allocating to different embryos, through simulations, the variability in development rates and stage at hatch observed during our study. Results are expected to enhance our ability to monitor and predict embryo development, which is expected to help improve predictions of larval release time in nature and accuracy of modelled connectivity between lobster stocks.

Integrated Watershed Management: A Case Study in Collaborative Strategic Planning between Clean Annapolis River Project and the Municipality of the County of Annapolis

Levi **Cliche**[1] and Katie McLean[2]
[1] *Clean Annapolis River Project, Annapolis Royal, NS (levicliche@annapolisriver.ca)*
[2] *Clean Annapolis River Project, Annapolis Royal, NS (katiemclean@annapolisriver.ca)*

The Annapolis River watershed is the third largest watershed in Nova Scotia, draining an area of 2250 km^2. Originating at Caribou Bog in the western Annapolis Valley, the Annapolis River flows downstream through portions of Kings, Annapolis and Digby Counties, into the Annapolis Basin, a sub-basin of the Bay of Fundy. Clean Annapolis River Project (CARP), a community based non-government organization, has been working in this area since 1990 to address ecological issues at a watershed scale.

Recognizing the importance of integrated watershed management, CARP has continually worked to develop strong working relationships with the various decision makers and stakeholders across the watershed. In 2017 CARP partnered with the Municipality of the County of Annapolis to undertake a consultative process with community members and stakeholders in the Annapolis River watershed, in order to guide the integration of community and stakeholder values, CARP's organizational strategy, and the County of Annapolis' Economic Development Strategy 2050, toward ecological management actions that support cultural, social, economic, and environmental values.

By undertaking this process with support of the Municipality, CARP is better positioned to focus its efforts on the issues of greatest import and impact to the residents of the region while aligning and supporting the existing municipal initiatives, particularly the County's policy to "support and foster efforts to remediate, manage, and ensure clean air, water, and soil." Key community concerns served as the themes for subsequent stakeholder meetings and will be used to develop future collaborative projects among stakeholders.

Characterizing the Horse Mussel (*Modiolus modiolus*) Reef Population in the Bay of Fundy

Kelly **Hall**[1], Jessica A. Sameoto[2], Susan Gass[1], Craig J. Brown[3] and Stephane Kirchhoff[3]
[1] *Dalhousie University, Halifax, NS (kelly.hall@dal.ca, susan.gass@dal.ca)*
[2] *Fisheries and Oceans Canada, Dartmouth, NS (jessica.sameoto@dfo-mpo.gc.ca)*
[3] *Nova Scotia Community College – Applied Ocean Research, Dartmouth, NS (craig.brown@nscc.ca, stephane.kirchhoff@nscc.ca)*

Horse mussels (*Modiolus modiolus*) have been known to exist in the Bay of Fundy (BoF) for a long time, but their current population structure is unknown. Horse mussels can provide important biogenic habitat and in 2012 Fisheries and Oceans Canada (DFO) designated an area of mussel reef in the BoF as an ecologically and biologically significant area (EBSA). The objective of this study was to characterize the current population structure of horse mussels in this EBSA. In the summer of 2017, physical samples were collected from 19 stations in areas identified as potential *Modiolus* reef with a modified scallop dredge lined with a 38 mm mesh. From each station, all live and dead (empty hinged shell) horse mussels were collected and returned to the Bedford Institute of Oceanography for processing. Population characteristics were obtained from mussels that were either live and intact, live with crushed shell, or dead. This included sex, viscera wet and dry weights, and valve lengths, heights, widths and weights. Live horse mussels were found in 13 of the 19 stations sampled. Results to date indicate that there are more females than males in the population (female to male ratio of 2.3:1), with the majority of both sexes between 90 and 150 mm in length, and few juveniles observed. This study provides important information

on the current population status of horse mussels in the BoF which will aid DFO in determining future management of this area.

Using Temperature-Dependent Embryonic Growth Models to Predict Time of Hatch of American lobster, *Homarus americanus*, in Nature

Erin H. **Miller**[1] and Rémy Rochette[2]
[1]*University of New Brunswick, Saint John, NB (t0008@unb.ca)*
[2]*University of New Brunswick, Saint John, NB (rochette@unb.ca)*

Hatch time affects the temperature experienced by developing American lobster (*Homarus americanus*) larvae, and hence the time and distance they will drift before settling. In principle this hatch time can be estimated over large geographic areas by working with fishermen and inspecting the brood of gravid females caught in their traps. However, this requires frequent sampling, given the hatch period is protracted, and (more importantly) would often require dedicated and expensive sampling as hatch occurs "outside" of the fishing season over much of the species' range. To address these limitations, we tested the accuracy with which hatch time in nature can be predicted by (1) taking egg samples during the fishing season, (2) estimating embryo development using embryonic eye size and lab-derived temperature-dependent development functions, and (3) comparing predicted hatch dates to the period of hatch observed by sampling out-of-season alongside fishermen. Utilizing samples obtained prior to the beginning of hatch we were able to predict with surprising accuracy the period over which hatch occurred, including hatches up to ≈ 15 weeks in the future, as well as the progression of hatch over this period. Our results suggest that samples can be obtained in collaboration with fishermen to predict hatch time with sufficient accuracy to enhance our ability to predict spatial connectivity via dispersal of larvae, which will become increasingly important as climate change alters oceanographic conditions.

Expansion of the Bay of Fundy Western Hemisphere Shorebird Reserve Network Designation

Kerry Lee **Morris-Cormier** [1] and Craig Smith[2]
[1] *Nature Conservancy of Canada, Amherst, NS (kerry.cormier@natureconservancy.ca)*
[2] *Nature Conservancy of Canada, Halifax, NS (*craig.smith@natureconservancy.ca*)*

For the past 30 years, Shepody Bay and the Southern Bight of Minas Basin in the inner Bay of Fundy have been internationally recognized as important to shorebirds through the Western Hemisphere Shorebird Reserve Network (WHSRN) designation. Findings from recent research (2011–2016) conducted jointly by Mount Allison University and Environment and Climate Change Canada's Canadian Wildlife Service, and data from aerial survey counts (1976–2014) of Semipalmated Sandpipers, have identified intertidal mudflats and beaches where large groups of shorebirds congregate outside of the current WHSRN site. The Nature Conservancy of Canada (NCC) is working to have these areas recognized to help improve the conservation outcome of the world population of Semipalmated Sandpipers *(Caladris pusilla) and* Red Knot rufa subspecies *(Caladris canutus rufa).* In fall of 2018, NCC will apply to WHSRN Council seeking a nomination for the expansion of the current Bay of Fundy WHSRN site to include Cumberland Basin and Cobequid Bay in New Brunswick and Nova Scotia. If accepted, all four areas will be formally recognized as a WHSRN "Landscape of Hemispheric Importance".